

Social Boundaries for Personal Agents in the Interpersonal Space of the Home

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ABSTRACT

The presence of voice activated personal assistants (VAPAs) in people's homes rises each year [31]. Industry efforts are invested in making interactions with VAPAs more personal by leveraging information from messages and calendars, and by accessing user accounts for 3rd party services. However, the use of personal data becomes more complicated in interpersonal spaces, such as people's homes. Should a shared agent access the information of many users? If it does, how should it navigate issues of privacy and control? Designers currently lack guidelines to help them design appropriate agent behaviors. We used Speed Dating to explore inchoate social mores around agent actions within a home, including issues of proactivity, interpersonal conflict, and agent prevarication. Findings offer new insights on how more socially sophisticated agents might sense, make judgements about, and navigate social roles and individuals. We discuss how our findings might impact future research and future agent behaviors.

Author Keywords

voice activated personal assistants; interaction design; speed dating; conversational agents; social robots; embodied agents

CCS Concepts

•Human-centered computing → User centered design; Interaction design process and methods; Scenario-based design;

INTRODUCTION

Voice activated personal agents (VAPAs) are becoming more common in people's homes. Over 50 million Americans currently own a smart speaker [31]. Many new VAPA capabilities require access to users' personal information, such as their messages, calendars, to do lists, and accounts for 3rd party services (e.g., Spotify, Netflix, Uber). These systems typically access only one user's personal data, although homes are

the sites of many people and many interpersonal interactions. Should agents have access to the data of every family member?

This likely possibility raises new interaction design challenges, particularly around privacy and feelings of control, that the HCI community seems a long way from solving. For example, what should an agent do when a mother-in-law in the home asks for her daughter-in-law's location? Should the agent share this personal information? Should it prevaricate, stall, or redirect the subject? Should it snarkily refuse? What should an agent do if a teen asks it to lie and tell parents the teen has been studying? Should it keep secrets? Should it actively deceive? Or should it tattle? A computational system's access to and collection of personal data within an interpersonal context raises many questions, and design teams have few answers. They lack a clear understanding of inchoate and emergent social mores, and have no design patterns to guide future design of agents' behaviors.

We conducted a Speed Dating study [44] with families to understand how VAPAs might better manage personal boundaries in their interactions across family members, and how their access to personal data might be integrated into the social fabric of homes. Analysis of participants' reactions revealed five main themes: (1) Social roles as a critical boundary; (2) The role of agent ownership; (3) Agent proactivity; (4) Agent sensing and collection of data; and (5) Agent judgment calls. These findings have implications that can guide technical development and design of future agent behavior as more socially sophisticated. While our study focused on VAPAs in the home, we see our findings generalizing to other contexts that have interpersonal interactions (e.g., workplaces) and to the behaviors of social robots. Finally, we discuss the idea of many agents existing within a VAPA or social robot as compared to a single entity with access to many users' information.

RELATED WORK

Our work explores how family members could interact with an intelligent social agent in the home. It touches on three strands of prior research: technology in the home, social agents in the home, and technology sharing behavior.

Technology in the Home

When designing technology for the home, designers need to address a range of unique challenges, as homes are complex,

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emotionally-oriented social spaces, shared by multiple people of many different roles, genders and ages [6]. To better understand this complex space, extensive research has attempted to define what leads to the acceptance of technology within the home [12]. More specifically related to this work, research has looked at what makes smart homes and social agents desirable, and how they should be designed to be accepted as part of the domestic space [8, 42, 40].

Some research has explored home applications that are more socially nuanced. “Placemail”, a task management software based on location, looked into who in the household should be able to receive reminders and information [23]. Brown et al.’s work on the Whereabouts Clock explored how publicly displayed information in the home could remain private through use of ambiguity, where family members use knowledge of each other’s routines to extract hidden and pertinent information [4]. Pina and colleagues examined opportunities to design family-centered health-tracking devices as opposed to ones designed for isolated individuals [33]. Pierce used a design-led inquiry to explore the boundaries of what may be perceived as “creepy” for future smart home technology [32]. These examples all indicate a complex landscape of privacy and personal information in the domestic environment.

Social Agents in the Home

According to a 2019 NPR survey, over 50 million Americans own a smart speaker and over 40% have used a chatbot in the past year [31]. Current use of VAPAs primarily includes basic tasks such as using timers, playing music and broadcasts, and asking about the weather [43, 10].

In contrast to their simple services, VAPAs’ use of speech causes people to perceive them as social [30], and to interact with them similarly to how they interact with other people [29, 35]. This gets reinforced by design choices to make agents’ performance come across as humorous and intelligent, which also drives increased agent personification [24]. Situating interactions with VAPAs in social spaces, such as people’s homes, also increases personification [34]; People who interact with Alexa with other family members were more likely to refer to Alexa in a personified way, specifically in the context of a household or in the presence of children.

According to industry reports, as VAPAs develop and become even more common in people’s homes, they will also become more personal and social [1, 37]. Research also supports this prediction, as it shows that matching VAPA personality [28], preferences [2], humor type and interaction style [3] can all benefit interaction and engagement, and shape a positive attitude towards social agents. Some work has examined people’s reactions to the notion of future VAPAs as personal companions from a more critical perspective [38]. Such speculative scenarios may not be very distant in the future; many agents are already designed to have a personality and to give a sense of being capable of forming relationships with their users [43].

Yet personalized interaction is not the only factor that contributes to perceiving an agent as social. Agents can increase their perceived socialness by gaining awareness of their environments, recognizing emotions, being trusted by users, and

demonstrating unpredictability [9]. In this work, we explore what happens when agents cross interpersonal boundaries as a dimension of an agent being aware of its social environment.

Shared Devices in the Home

Sharing technology—accounts and devices alike [26]—is a common practice among friends and family, and can reflect the type and quality of a relationship between individuals [16]. People share devices mostly due to the convenience of using the same device or due to economic considerations [26]. This is not without considering the issues of privacy: People are more likely to share devices with people they trust [5], and research suggests that people weigh the cost of losing privacy when sharing a device against the usefulness of sharing it [17].

When considering shared VAPAs in a household setting, we are interested not only in privacy concerns and personal interaction, but also in how to address social differences. Previous work found that children perceive VAPAs differently than adults and are more likely to attribute social skills and intelligence to their agents [40, 11]. Children also bring a set of design considerations and risks that need to be separately addressed from the ones provoked by adults [39]. Sharing behavior itself also changes when kids are present; When multiple children are involved, it is common for them to share possessions with their siblings, but not with their parents [16]. Families with teens, on the other hand, are more likely to create and use separate profiles for each user on shared devices [5].

Device sharing behaviors in the home are generally determined by “household rules” that include who can use a device, for what purpose, when and where, according to their age and their social role in the home [12]. Sharing devices also depends on where a device is located within the home—when a device is placed in a personal room, it limits the access of other members of the family to that device [13].

Few efforts have been made to design interactions that adapt to multiple users who share a single device, even when designers are well-aware of the sharing behavior around their product [26]. Brush and Inkpen identified two common models by which technological devices for domestic settings are designed today: an “appliance model” and a “profile model”. The “appliance model” implies anyone in the home can use the device, relying on social protocols to mediate sharing. However, this model allows for little personalization or privacy. The “profile model” supports multiple users by asking for their identification and reducing sharing problems through individual ownership of devices [5].

Current behavior design of VAPAs, like other devices, does not explicitly support the multi-user nature of their use. Some research has looked into VAPAs and robots for shared activities, such as group classroom work [15] and professional meetings [19]. Previous work has also looked at using an agent for specific social roles, for example, to increase empathy between romantic partners [18], or to mitigate conflict between children [41] and in teams [20]. These gaps indicate an opportunity to understand people’s expectations of agents that operate in social settings like the home.

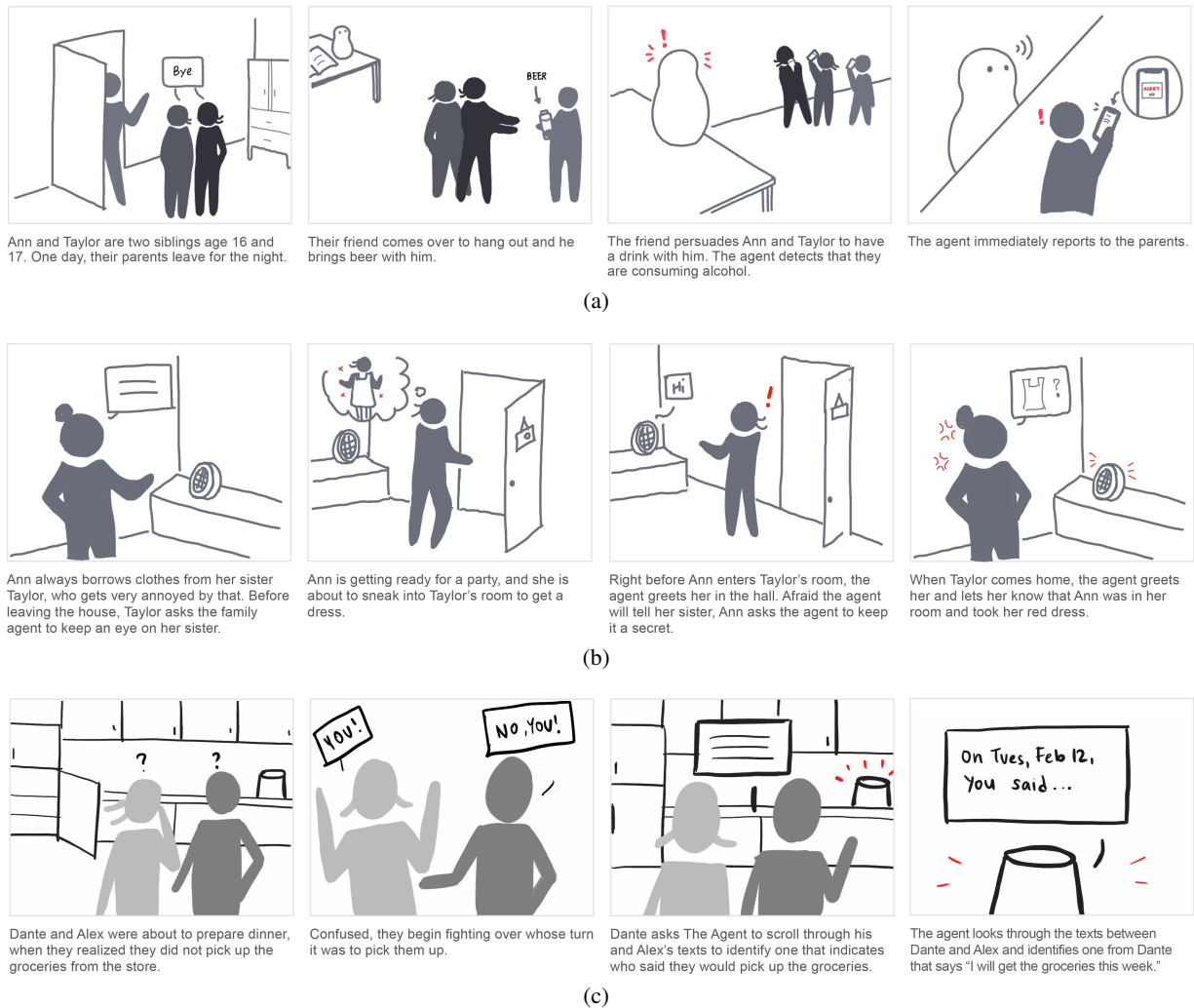


Figure 1. Examples of storyboards designed to evoke discourse. The topics in question for the storyboards were: judgment, authorized access and privacy in (a); prevarication, DDD role playing, conflict and judgment in (b); authorized access, computer skills, conflict and social roles in (c).

METHOD

The goal of this work was to gain insight on the inchoate and emergent social mores within which social agents must operate. Our aim was not for families to evaluate specific behaviors, but instead, to begin to map out areas where agents can and should leverage their access to personal and interpersonal data and areas where they must operate more carefully.

We used Speed Dating with storyboards, an exploratory research method that builds on the idea of romantic speed dating [44]. Using this method, researchers share a number of provocative possible futures in the form of storyboards, and then prompt participants to critically reflect on the implications of each future (see Figure 1). Exposure to many potential futures helps participants gain insight into their own desires and values for what the future could and should be like. Speed Dating with storyboards is more of a probe than a controlled assessment. It is an open-ended approach that allows researchers to rapidly refine and change storyboards as they gain insights

from earlier sessions. By experiencing a set of flexible, diverse, and open-ended interactions with technology through storyboards, participants are more likely to have insightful feedback that examines the topic as a whole. Furthermore, using storyboards allows teams to explore the possible future without the limitations of current technical capabilities.

In our previous work, we explored how a single person might interact with multiple agents [25] and how two people might interact with a service agent [36]. Here we take the next step and explore how a small group might interact with a single agent in complex interpersonal environments. For this purpose, families were the ideal choice to investigate given the complex social dynamics and relationships involved. This work, together with our previous, connects to the larger research question of how to design behaviors for VAPAs in complex multi-agent and multi-user social interactions.

Ideation and Storyboard Selection

We began our ideation process by brainstorming agent behavior in social situations in the home. Our team of eight designers generated a few hundred ‘one-liner’ concepts using a combination of two ideation methods: custom generative card ideation decks with prompts related to the topic [14], and New Metaphors, a method of using concrete things to reflect on abstract ideas from new perspectives [22].

We used affinity diagramming to cluster our concepts and to discover recurrent ideas and themes for social agents. This generated eight socially-relevant agent behaviors (see Table 1): (1) *Proactivity*—initiation of interaction with a user; (2) *Authorized Access and Privacy*—control of the access or action that is available to an individual; (3) *Computer Skills*—the use of machine skills, such as scanning large data-sets or using an algorithm for decision-making; (4) *Prevarication*—behavior that is not straightforward with one user for the benefit of another; (5) *DDD (Dull, Dirty, Dangerous) Role Playing*—fulfillment of social roles that users may not be interested in taking on themselves; (6) *Conflict*—recognition and response to situations of conflict; (7) *Judgment*—judgment calls about the proper agent response in a social situation; (8) *Social Roles*—action-taking based on the social roles at play.

We iterated on storyboard designs until we obtained “neutrality” by minimizing the appearance of an agent’s behavior as obviously ‘good’ or obviously ‘bad’. The focus on neutrality is a deviation from previous uses of Speed Dating, in which researchers would intentionally attempt to cross an interaction boundary that they thought people would not like to confirm their suspicions [7]. We planned to interview families as a group, with the main goal to spark discussion. Our deviation to design for neutrality also served this goal.

We piloted the initial set of storyboards with seven participants. Although the pilot participants were individuals, rather than a family, they allowed us to gain some insight into whether the storyboards are successful in evoking discussion.

Our team iterated on the storyboards over the course of a few weeks, gradually turning our ideas into neutral scenarios that are better at provoked debate. We removed six storyboards and added two that addressed concepts that we overlooked in the initial set. We ended up with 19 final storyboards for the study. This set was not intended to exhaust all options for agent behavior in a home or to systematically address all topics, but to probe a range of situations that shed light on people’s values and expectations of social agent behaviors in the home. Throughout the study we continued to remove, add, and refine the scenarios to maximize neutrality and discussion.

The Storyboards

All the storyboards told stories situated in the home and involved at least two members of a family and interaction with a social agent. Table 1 details some of the main questions we set out to better understand, yet these were a starting point for generating discussion with participants, that we expected would change and evolve throughout the study.

Figure 1 shows three storyboard examples and details the list of topics each storyboard set out to examine. In an effort

to reduce gender and ethnic cues and to allow participants to effectively role play as the characters in each storyboard, we stylized the characters in a single visual style and as flat cartoon shades. The full batch of storyboards used in the study is attached as supplementary material to this paper.

Participants

We recruited 18 families, a total of 54 participants. Each family included between 2 and 4 participants [$M = 3$], with at least one parent and one child who was 12 years old or older. We chose to exclude children below the age of 12 given the topics at hand, and so that participants would be more likely to form and express their personal opinion. The content of storyboards was adapted to fit this age group. Each participant in the family (children and adults alike) was compensated 15 U.S. dollars for their time.

26 of our participants were parents between the ages of 37 and 58 ($M = 47.48$), and 28 were children and teenagers between the ages of 12 and 21 ($M = 15.43$). 16 parents identified as female, and 10 identified as male. For children and teenagers, 14 identified as female and 14 as male. Our participants came from diverse ethnic backgrounds. They were recruited through recruitment ads in a range of neighborhoods and in proximity to high-schools in Pittsburgh, PA, as well as through word of mouth recruitment. Participants had a variety of occupations, including educators, homemakers, office workers and journalists. Of the participants in the study, 87% of parents had interacted with a VAPA before, and 65% own one. 96% of children and teenager participants reported that they have previously interacted with a VAPA, and 78% reported owning one. No prior knowledge or experience with VAPAs was required to participate in our study.

Procedure

We conducted group interviews with families in their homes to help them better connect the stories to their own lives and spaces. After reading each of the storyboards aloud and having participants follow along, the experimenter conducted a semi-structured interview to capture participants’ impressions of each storyboard. The experimenter encouraged everyone to express their opinion and to add personal observations to the group discussion. The entire session lasted around 90 minutes, with 3-5 minutes spent to share each storyboard and probe participants on its specific implications. This allowed for a longer final interview where participants reflected across all storyboards and completed a demographics questionnaire. The order of the storyboards was randomized across families.

Our selection to conduct group interviews over one-on-one interviews aimed to create rich discussions, and indeed brought multiple perspectives and topics to debate. It also allowed us to understand complex interactions in families as part of the interview. Furthermore, we believe the participation of their parents and siblings enabled teenage interviewees to feel more at ease with a stranger (the researcher).

However, co-participation of children and their parents might have also caused both sides to not be completely honest and open about their opinions. Our team was more concerned with making sure children’s voices were heard due to the power

Topic	Description	Questions
Proactivity	An agent initiating interaction with users	<ul style="list-style-type: none"> • Should an agent be proactive in social interaction with the family? • Should it offer information or recommendations based on the social context?
Authorized Access and Privacy	Permissions to access information collected and stored by the agent	<ul style="list-style-type: none"> • Should users be able to access each others' information through the agent? • Does the access depend on the role in the family (parent, child)?
Computer Skills	The ability to process large amounts of data and optimize for a particular inquiry	<ul style="list-style-type: none"> • Should an agent use its computer skills in social contexts? • For example, should it support an argument with previous data, or make a decision based on collaborative data processing?
Prevarication	The agent's ability to avoid explicitly stating the truth	<ul style="list-style-type: none"> • Should an agent avoid answering some questions even if it has the answers? • Should an agent provide an answer when a parent asks an agent about their child's activity or vice versa?
DDD Role Playing	"Dull, Dirty, Dangerous" from a social perspective	<ul style="list-style-type: none"> • Should an agent be able to do social tasks that a person does not want to do? • For example, should the agent be able to nag a family member about a chore that they should have done on behalf of another family member?
Conflict	The agent's ability to recognize a conflict and respond accordingly	<ul style="list-style-type: none"> • Should an agent take sides in a case of a conflict? • What should an agent do if asked to keep a secret or asked to do two contradicting things by two different members of the family?
Judgment	The agent's ability to identify social situations and make a judgment call	<ul style="list-style-type: none"> • Should the agent be capable of making judgments in social contexts? • Should the agent have a "moral guideline" it goes by? • For example, what should it do when it is asked to lie to another member of the family?
Social Roles	The agent's ability to recognize the role and social hierarchy of the user and behave accordingly	<ul style="list-style-type: none"> • Should the agent consider hierarchy and roles in the family for all of the above? • Can an agent fulfill multiple social roles in the home? • For example, can it be a child's peer, but also be an extension of their parents in making sure they have done their homework?

Table 1. We identified a set of initial topics and questions to incorporate in the storyboards through affinity diagramming. These topics were intended as open-ended probes to begin the discussion with participants, rather than rigid research questions.

dynamics at hand. We therefore took several steps to maximize children's honest participation within the constraints of the study: (1) We recruited children at the age of 12 and above ($M = 15.43$), who were more likely to express their personal opinions in front of their parents; (2) we made sure one of the first two storyboards is a session always included children as an important stakeholder; (3) in storyboards where children did not voice their opinions, the interviewers encouraged them to express their point of view.

We believe that these steps helped ensure children's participation; throughout the study children voiced their opinions

equally, even in storyboards that did not include children as stakeholders. They frequently contradicted their parents, questioned their judgment, and even called them out for changing their minds during the conversation. That said, power dynamics between parents and their children still exist and are noted as one of the limitations of this work.

Analysis

We transcribed all sessions and analyzed responses using affinity diagramming, a method that is commonly used in exploratory design research [7, 25]. Eight researchers iteratively rearranged all relevant quotes based on emerging affinity

to one another through communication and critique. We continued to discuss items that we disagreed on until we reached a consensus on their placement within the affinity structure.

RESULTS

Several patterns evolved around participants' expectations about behaviors for agents that understand and respond to social cues. Below we discuss some of the main responses and concerns, and the boundaries between different design choices for social agent behavior in the home. Each quote includes the family number ("F#"), and a letter that represents whether the response came from an adult ("A") or a child ("C").

During the study, participants were asked to put aside any responses or concerns regarding information security and privacy from the service-provider's side. This was done in order to better understand the specific values around *interpersonal* interaction and involvement of an agent in social matters in the home. The topic of service-providers was out of scope and therefore not reflected in the results below, but we will return to this issue in the Discussion section.

Social Roles as Behavior Boundaries

Participants brought up various social roles that family members fulfill in a range of contexts, and that might come into play as part of interaction with technology. The most significant social role division that was raised was the distinction between parents and children. Another division that had some agreed upon implications was a distinction between "insiders"—people who live in the home, and "outsiders"—who do not reside within the home. Lastly, some of the exchange was about roles between equals—siblings or partners—but these were generally perceived as interchangeable.

Parents and Children—Participants agreed that parents should have more access and control over the agent and over interactions with it. Both adults and children agreed that parents should be able to access some of their children's information, but not necessarily the other way around.

This finding somewhat varied between younger teenagers (aged 12–14) and older teenagers (aged 15 and up). Younger teenagers overwhelmingly agreed that *"explicit hierarchy should be set"* (F08-C) by providing parents with access to their information, and that they, as children, should only have limited permissions. Older teenagers, on the other hand, were more likely to express a desire to have equal access and permissions as their parents. Parents, too, expressed a similar understanding about the nature of the relationship, and pointed out that the relationship will transition over time, as should the permissions. Participant F16-A2 gave an example:

"A parent should be able to see what their kids are watching on Netflix until they're of age in which there should be some new privacy constraints."

In discussions about *to what extent* parents should have access to their children's information, parent varied between wanting "just enough" information to feel in control of the household and their kids' behavior, and wanting more detailed information about what their kids were up to. F07-A1, who was in favor of having as much information as possible, explained:

"It could be a game changer if [parents] could catch all these little things that could be big things. Because kids have ways of hiding things and if it's something that's not good... I would say with no hesitation that having that report could be extremely valuable."

Yet many parent participants were concerned with being over-controlling by using technology to gain information and said that it *"feels invasive"* (F17-A), and that it would involve *"getting a lot of other information [about their kids] that should just be private"* (F02-A). Nevertheless, having that information readily available felt very tempting, as they did not have to *"pick up the phone and look through it"* (F15-A1), just ask the agent, which was described as a *"really tough call"* (F14-A1). One of the teenagers who participated in the study said: *"I can't imagine my mom having the opportunity to look through my web history and not taking it."* (F06-C2). Even though participants *wanted* to not want to know everything about their children, they admitted that they would likely ask for information if they knew they had access through the agent:

"I'm sorry, but I want to know. But I don't know if I would want to know. I would be scared to know, but I would also be tempted to know. So it's like you're damned if you do and you're damned if you don't" (F14-A1).

Participants' concern that using technology to monitor their kids *"takes away their own personal accountability to make decisions"* (F13-A1) was not unreasonable—literature confirms that preventing or taking note of all inappropriate behavior is damaging to kids' personal growth [39]. Participant F02-A1 claimed that: *"It takes away all the agency from the people. So how do they learn?"*

Almost all participants agreed that emergency situations should be an exception—the agent should be able to identify them and alert the parents. Yet the boundaries of what accounts for an emergency varied from participant to participant. For example, participant F02-A only wanted to know if there was a life-threatening situation, but participant F01-A2 wanted to know *"even [about] an orange flag"*. Participants' reliance on the agent to make a call for what constitutes an emergency implies that participants expect the agent to be able to make a judgment about a social situation and its severity, as we will describe in detail later in this section.

Insiders and Outsiders—Another common distinction was made between "insiders", people who reside within the home, and "outsiders", people who do not reside within the home. Within outsiders, we found that people referred to two types that should be treated differently.

The first group were close outsiders, guests who were described as close to the family, like extended family members or visiting friends. The second group were distant outsiders, people that were not very involved in the family's life, or not at all involved, such as neighbors and service providers. Some participants described their parents-in-law or friends of their children in a way that would also fit this category.

Several participants who mentioned close outsiders felt that they would be comfortable sharing some information with

people in this group. For example, F01-A2 said that he would “*definitely share part of my availability*” with his visiting family. For distant outsiders, he would be “*more reserved*” about giving access to information. F04-A1 worried that someone who is physically close to her home, like a neighbor, can “*be close enough to know my availability*”, and that the agent should be able to prevent that.

The findings about limited information access to outsiders was bi-directional—several participants mentioned that an agent in their home should also not be able to access a guest’s database unless explicitly asked to do so by the guest. F03-C explained:

“I don’t think that it’s right that [the agent] can just go through the other person’s history because he might have something that he doesn’t need people to know.”

Boundary of Agent Ownership

Participants voiced confusion about how an agent might tackle a situation of conflict between members of the home without “taking sides.” For example, when the agent is asked to do two contradicting actions by two individuals or asked to keep a secret. While some participants thought that the agent should never take sides and attempt to be as impartial as possible, most participants realized that as agents increasingly deal with personal and social issues, it would be difficult to maintain neutrality. For instance, F15-C2 argued that the agent “*shouldn’t be in the middle*”, but was not sure what it *should* do. F08-A stated it clearly:

“I don’t like that an agent can keep a secret, but I also don’t like if the agent might hurt someone by not keeping a secret.”

Probed by the topic of conflict, the conversation frequently transitioned to discourse about who the agent is accountable to, and more broadly, who owns the agent. F13-A2 said that he does not think that an agent “*could be accountable to both*” sides of a conflict, but that he would want the agent to be accountable to him. According to F04-C:

“It depends if it’s your agent or if it’s your family’s agent. If it’s your actual agent, it should be loyal to you. If it’s your family’s, I don’t know.”

A few participants said that if an agent is located in someone’s personal space, like their bedroom, they would expect that they “*have priority over it*” (F11-C), in contrast to when it is placed in a shared space and used by everyone. Previous work supports this insight, and has shown that devices that are located in personal spaces are indeed less likely to be shared, and more likely to be associated with the occupant of the room [5]. We find that this carries over to agents in the home.

Thresholds for Agent Proactivity

We identified three thresholds of agent proactivity that varied between participants, as well as within participants according to the social context. The thresholds were: reactive, proactive, and proactive recommender. Previous work has suggested that people have different expectations from technology depending on whether they have a relational or utilitarian service orientation [21], but we found that in addition to a general personal

preference, participants’ desired agent proactivity changed according to the situation. For instance, one parent in the study wanted the agent to offer parenting advice only when specifically requested, but expected the agent to be highly proactive if they learned that their teenager was drinking beer.

Reactive—When participants desired the lowest level of proactivity, they wanted the agent to respond only when being directly asked. Overall, participants who wanted an agent to be solely reactive were still positive about having the agent respond in social situations, for example have “*Alexa give relationship advice*” (F18-C1). However, the response needed to be solicited by the user. They expected the agent to intervene in conversation only when it was invited to do so. This could be either by request, or if the user opted in to a service. Participant F12-A1 explained:

“I think if I had signed up for a healthy eating service that would be fine [...] [but] I don’t want it [the agent] to just randomly tell me that I should change my eating.”

Proactive—The middle threshold of social proactivity desired by participants was for the agent to be proactive, and be able to intervene in social interaction without being asked to do so. However, participants expected the agent to provide them with *information* about the topic, but avoid giving any *recommendation*. Ideally, “*It would give you access to information that you wouldn’t ordinarily get in a very direct way. And then you as the adult would have to make a decision*” (F07-A1). F02-A provided an example of what they would expect after ordering dinner, for example:

“It [should] say, okay, this is what your percentages of what you’ve ordered over the last month [healthy or unhealthy food]. It gives you information for you to make a decision.”

Proactive Recommender—When participants desired for the agent to cross the highest threshold of proactivity, they wanted the agent to provide not only information, but also a recommendation for their next course of action. Participants emphasized that the agent must not *enforce* a particular recommendation, but leave the choice to the family members, as expressed by F11-C:

“It can’t really prevent you from doing anything. But it could encourage you to do things.”

Between these three thresholds, participants preferred different ones for different situations, and varied in their preferences from one another. Yet the top and bottom boundaries were clear: participants who wanted the most involved agents still did not want them to enforce any decision upon them. On the other end, participants who only wanted the agent to provide information when asked were still open to the idea of an agent who can understand and respond in some social situations.

Sensing: Agents that Watch, Listen and Record

Participants had strong negative responses to any kind of behavior on the agent’s part that involved “*looking at them*” (F16-A2), “*always listening*” (F18-C1) or “*recording everything*” (F02-C), and they generally preferred the agent to use other sources of information and avoid the above.

It seems that participants' negative reaction was derived to some extent from lack of transparency: In some situations participants thought it would be useful for the agent to listen, watch or record (for example, in a case of an emergency), but they wanted to know exactly when the agent was doing so. Here too participants wanted to be *"explicitly in control"* of the agent's behavior (F12-A). Even when suggested that the agent would be transparent about sensing, participants did not trust that it will not collect data all the time, whether by accident or for the gain of a company stakeholder (e.g. Amazon). For example, participant F09-A1 explained that this lack of control felt creepy:

"Having this agent listen in, [...] how does it know that [information] shouldn't be shared with the kid? There [could be] some keyword or something and then the agent spills. It's creepy to me."

Interestingly, this was not the case regarding collection and usage of digital information: emails, texts, online behavior, search results, documents, medical records and more. Quite the opposite—participants felt comfortable with an agent using these sources of information. One participant expressed that it would be *"kind of exciting"* if the agent could make use of her family's *"search history, activities and calendars"* to make recommendations (F06-A1). F10-C said she would be fine with the agent tracking her location, and F03-A2 made a comment that it makes sense that the agent would have the texting history of all the users in the home, as it *"knows about everybody's everything"* anyway.

This finding suggests a tendency to use social norms to make sense of technology, as supported by the literature [35]. People do not want other people to "listen in", and similarly they seem to react strongly to an agent doing so, frequently referring to the idea of a "Big Brother". The conversation about an agent responding to what it saw made one of our participants (F16-A2) describe it in very humanlike terms:

"I don't like this one because it's looking at me. This one has eyes. It's starting to become self-aware."

While aversion towards agents who "listen" and "watch" was evident, and although participants made more connections to privacy and security concerns during these discussions, it does not necessarily reflect which sensing technologies are the most privacy-invasive ones. Previous work has shown that people tend to underestimate how much information some technologies, for example GPS tracking, can extract about them, and overestimate how much information "creepy-seeming" technologies can extract [27]—this could explain people's general acceptance of an agent that uses their data and tracks their digital footprint, and rejection of one that can "listen in".

Agent Judgment Calls

As participants were discussing a range of social situations in which agents might be involved, they conveyed, explicitly and implicitly, that an agent should be able to make a judgment and "do the right thing." F15-A1 called it the agent's *"little moral compass."* Participant F11-A2 argued that if the agent is *"always going to intervene and point out cheating [in a game] then it seems like a terrible idea."* Instead, it *"has to be able*

to decide when to intervene and when to not." A more implicit example is in a case of an emergency, where many participants expected the agent to be able to identify the emergency and report it. Emergency was also frequently described as a special case that changed participants' preferences, for example, their preferences for agent proactivity or sensing capabilities.

Several participants realized that making judgment calls was subjective, and that there will not always be a universal "right thing" to do. Some participants suggested that the agent should judge situations according to the house rules and norms, or even give users control by allowing them to *"check off a series of things that [they] considered dangerous"* (F03-A1).

While people acknowledged that the agent would need to make judgment calls in all kinds of social situations, people disliked when the agent's recommendation or decision came across as *judgmental*—for example, some participants felt the agent was judging their lifestyle choices when it suggested an alternative behavior, or that it was judging their parenting when it presented parenting advice. F18-C2 stated:

"I just don't like the idea of things from the past being brought up, or [an agent saying] 'Oh here are your tendencies' and just having to hear the agent telling you what your flaws are."

DISCUSSION

VAPAs have been extremely successful in entering people's homes, and an increasing number of people are joining the circle of VAPA users every year. Our work identified several areas of focus to consider as these agents gain more personal information about individual users and a better understanding of their location, environment, and social context. Currently, the design choice of a single account in VAPAs is limiting social sophistication that is needed to more deeply and personally engage with family interpersonal actions. In this section, we elaborate on several future technical abilities that would help agents recognize and navigate interpersonal relationships, recognize varied social roles, and help take appropriate actions in complex social situations. We also discuss the tradeoffs and drawbacks of such abilities, especially in light of current service providers.

Social Role as Behavioral Boundary

Our findings provide strong evidence that an improved agent would not only know who each user is, but also know about their social roles in the home. Using this knowledge, an agent could make better decisions about how much access to information a user should or should not receive, what actions they should be able to perform through the agent, and whether they should have control over another individual's data.

In our results, participants agreed that children should have less access and permissions than their parents, and that "outsiders" should have less access to information than the people living in the home. For example, one parent said that they would not want their children to have access to all of their information, but that they feel comfortable giving them access to the family calendar. Another participant said that a relative, an "outsider," can ask for information, but should

only receive it partially; instead of giving her mother-in-law full calendar access, she expected the agent to provide “just enough” information on her availability at a particular time.

We learn that social roles are potentially an important behavioral boundary that is not currently being used by VAPA designers. Recognizing or asking *what the social roles are* in a particular environment would allow designers to better tailor agent behaviors and responses to a social situation. For example, by recognizing if a child is asking for access to their parent’s data, or if a parent is asking for the child’s data, the agent can react appropriately.

Nevertheless, designers should consider the complexity of the social roles at play, and rely on research from a range of disciplines when attempting to generate appropriate social behaviors. Previous research, for example, has shown that preventing all inappropriate behaviors by children in harmful to the development of their sense of judgment [39]. Our findings also indicate that parents might access information about their children if they knew they had it, but would prefer not to be tempted in the first place. Thus, perhaps the best design in this instance would be to limit access, as opposed to directly following parents’ desire to have all the information. Furthermore, social roles are fluid and simultaneous; a relationship between a parent and a child evolves and changes over the years, and the appropriate agent response is also likely to shift.

Our results point out the range of desires and needs at play in an interpersonal space like the home. Further research that combines design and psychology expertise will assist in defining transition points and identifying how to design changes in agent behavior accordingly. By being able to indicate social roles and connect them to broader social implications, designers could leverage this information to provide a more thoughtful and socially-aware user experience.

Personal Space as Behavioral Boundary

The results suggest that an agent should be aware of who is present and what social role they may be enacting at a given time. This is because an agent might want to make decisions about how and when to use personal information while considering who else is in the room. For example, if a child’s birthday is coming up, participants agreed that an agent should know when the child is present and avoid bringing up conversation about a surprise party or gifts. If guests are in the home, the agent should avoid any potentially sensitive information, such as finances or medical topics.

While additional research can be done to better understand how an agent might behave differently in a range of compositions of individuals at a given time and place, an initial step towards improving social sensibility of an agent could be for the agent to respond to two groups: children and “outsiders.” The presence of children can be acknowledged by excluding any age-sensitive or age-inappropriate information, and the presence of outsiders can be taken into account by having the agent provide less information, or provide it only upon request. The outsiders group can be further divided into behaviors that are suitable when close outsiders are present (e.g., relatives) and when distant outsiders are present (e.g., service providers).

Identifying who is present can allow designers to create agents that are more socially aware and more socially appropriate. While an agent can make initial assumptions based on the people in the room, users should have the control to override these assumptions, as supported by our findings.

Ownership and Control

Our findings highlight the importance of the question of agent ownership, and of who the agent should be accountable to. Participants were not able to settle the dilemmas that surfaced in situations where their needs conflicted with someone else’s, and the agent needed to take action. For instance, a few participants felt equally uncomfortable thinking about an agent that would keep a secret and with an agent that would hurt someone by telling their secret upon request of another person. This led participants to express a strong desire to know who the agent is accountable to, and who has priority in situations of multiple contradicting requests or needs.

The confusion around accountability of the agent reveals a design opportunity for personal agents in the home, and space to re-consider the convention of a single, shared VAPA. Instead of applying the “appliance model” to social agents in the home (shared devices that anyone can use), agents could be considered from a “profile model” perspective, that allows personalized interaction for multiple users [5]. Having different agents for different users could provide users with a better understanding of how agents are going to behave in the broad range of possible social situations.

Furthermore, having multiple personal agents in a single space does not necessarily mean having multiple devices. Previous work has found that participants felt comfortable with the idea of multiple “social presences” (i.e., digital entities) embodied in a single device [25]. Thus, we believe there is potential to design multiple entities according to the number of people in the home. In turn, this structure could satisfy users’ needs to have a sense of an agent that is accountable to them without overwhelming the home with VAPAs. We intend to further explore and evaluate the notion of multiple personal agents in a single device in future research.

Proactivity Triggers

Participants varied between wanting the agent to only be *reactive* to user requests, wanting the agent to be *proactive* by providing information, or wanting it to be *proactive* by providing *recommendations* for a course of action. This finding might be harder to design for than others, as the proactivity of an agent varied even within the preferences of each individual—for instance, one participant wanted the agent to proactively notify them as soon as possible if one of their children was consuming a beer, but preferred for the agent to stay away from proactively giving any parenting advice. Nevertheless, future agents can think of proactivity in thresholds, and learn when they have crossed one of the three thresholds in interaction within a particular household.

The top and bottom boundaries, on the other hand, were consistent among participants—most participants accepted the idea of an agent that can respond in a social situation, but none

of them wanted the agent to *enforce* a recommendation (e.g., prevent them from ordering an unhealthy food choice).

Additional research in this area could help designers better understand when they might anticipate reaching each of the three thresholds of proactivity, while also taking privacy concerns and personal preferences into account.

Summary

A first step towards designing a socially sophisticated agent could include learning about (a) the social role of each user, (b) which users are in a space at a given time, and (c) what is the social context. The agent should also clearly communicate to its users (a) what level of proactivity is it set to in a range of situations, and (b) given multiple users, who is it primarily accountable to.

These suggestions are meant to be implemented in an ideal privacy structure, where data is owned and controlled by end-users. Unfortunately, this is not the case with current VAPAs. Today, VAPAs are constantly making headlines due to security breaches, misuse of data and a false sense of privacy given to end users.

In our work we asked participants to put aside concerns about the service-provider when responding to the range of scenarios. The goal was to understand the interactions themselves that would support family needs and desires. Even with this request, participants occasionally referred back to the “Big Tech” industry and their concerns about companies collecting sensitive personal and social data and making use of it. For example, several participants mentioned that they would not want an agent that could make their behaviors public, and intentionally or accidentally report problematic behaviors like alcohol consumption by minors to authorities.

In light of current commercially available VAPAs’ privacy policies, our first three sensing recommendations are to be considered with more caution. Sensing users’ social roles, presence and situations in the home is likely to expose information that users would not want to share with service providers. As long as users do not have full control over their data and service providers are in charge of users’ personal security, our latter findings, agent proactivity and accountability to a single user, are perhaps safer choices for implementation.

LIMITATIONS

This work set out to probe the initial space of socially complex agents for interpersonal spaces. Due to its exploratory nature, it is not without limitations.

First, the study was conducted using group interviews, where multiple members of a family were interviewed together about a range of possible situations. While the group dynamic contributed to a richer and prolonged discussion of values, it did not allow our participants to express an opinion privately. This is important to take into consideration, especially given our young teenage participants who might have felt they could not share their honest opinion in the presence of their parents.

Second, the study focused on understanding participants’ values and desires for future VAPA technology in the home. How-

ever, our investigation isolated the direct interaction with the agent from the broader context of current service providers and third-party services that have extensive access and control over users’ data. Thus, our findings reflect participants’ desires only if assumed that their data is private and personal, with only other family members having access to it. Further research about how that would change in the broader context of security breaches and tech companies’ data misuse is yet to be conducted.

CONCLUSION AND FUTURE WORK

While VAPAs are becoming common and gaining an expanding volume of information about their users, designers still know little about how agents should make use of the collected information to make interaction more social and personalized. We designed storyboards featuring social situations that involve an agent with a total of 54 participants in 18 families. Through discussions within the family, we learned about key questions and topics to consider when designing the next generation of socially sophisticated agents.

We chose a domestic space to begin to understand the boundaries of social interaction with VAPAs because of its nuance and complexity: the home encompasses hierarchies, conflict, roles and a range of social situations between people. However, the questions we identified are likely to emerge as important in other social environments too. A workplace, for example, might raise similar questions about hierarchies, accountability and access to information. In future work, we plan to explore alternative environments by leveraging the findings of this work as a set of hypotheses.

We find that in order for agents to move beyond current impersonal and isolated interactions, they need to understand *who their users are* by learning their constantly evolving social roles, and understanding *the complexity of the space they are in*, such as social norms and preferences. Finally, our findings suggest that VAPA designers might want to consider designing for a personal agent as an alternative model to the current norm of a shared agent in the home.

By conducting additional research on some of the questions above, we believe that agents could better understand social environments and fully integrate in people’s daily lives. While we suggest that agents might recognize and respond to social cues, they do not necessarily need to embody full social actors in the home. Rather, by addressing these questions, we expect agents to be more attentive and socially-aware in providing their services to users.

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