Exploring Everyday Sharing Practices of Smart Speakers

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ABSTRACT

Smart devices like mobile phones, tablets, and smart watches are designed under the assumption that they will be used by a single user. In contrast, many other devices such as smart thermostats and smart speakers are inherently sharable. This paper presents preliminary results (based on a data set of 15 participants) from an ongoing multi-methods study (using diary study and semi-structured interviews) that aims to gain a nuanced understanding of motivators and constraints of sharing such smart devices, which are cumulatively referred to as Internet of Things. Specifically, this paper illuminates the purposes and practices of sharing smart speakers and discusses two influential factors that shape these practices. Finally, we discuss the implications of our findings and provide guidelines for the design of future smart conversational speakers.

CCS CONCEPTS

• **Human-centered computing** → **User studies**; **Empirical studies in HCI**.

KEYWORDS

Internet of Things; Smart Speakers; Sharing Practices

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Today, due to the increase of low-cost embedded sensors with networking capabilities multiple everyday objects have become *smart devices* that are collectively referred to as *Internet of Things* (IoT) [3]. Therefore, IoT in this paper refer to a collection of smart devices that automatically sense data about users or their environment, assist them in automating their spaces or activities, or help the users in gaining knowledge about themselves [5]. Examples of IoT, thus, can include smart speakers with voice assistant (referred to as smart speakers in this paper), wearables (e.g., activity trackers and smart watches), automated home systems (e.g., smart security systems and thermostats), or more traditional devices (e.g., phones, tablets, laptops, or desktop computers).

Prior work (e.g., [2, 8, 11, 12]) has shown that people share their devices (e.g., phones, tablets, and laptops) and online accounts (e.g., streaming accounts). But we still lack a systematic understanding of how constant connected Internet of Things (IoT) are shared. This paper discusses the sharing practices of smart speakers, which were obtained as part of a larger study that investigates families' sharing practices of IoT in general. The selection of smart speakers as the focus of this paper is intentional and is based on the facts that (1) smart speakers are designed and marketed as sharable devices (as compared to devices like phones, wearables, which are considered to be personal devices), (2) smart speakers are increasingly adopted by US households; today almost 25% of US households[1] own atleast one smart speaker, and (3) smart speakers enable constant voice-based connectivity that might lend flexible means of interacting with the device particularly for children and older adults [15] in the family. Therefore, this paper aims to answer the following research questions with respect to smart speakers: **RQ1:** With whom and for which purposes are the smart speakers shared? **RQ2:** What are the preferences and constraints of sharing smart speakers? How do these affect users' sharing practices?

1 BACKGROUND RELATED WORK

Our work is influenced by two broad streams of research as discussed below:

1.1 Studies Documenting Device Sharing

There has never been an incentive for the industry to allow people to share devices [1]. However, previous work has shown that people do share many of their devices, and researchers have studied families' sharing practices of personal computer (e.g., [2]), smart phones (e.g., [11, 14]), or tablets (e.g., [13]). While all of these studies have focussed on sharing of a single device, notable exceptions [8, 12, 16] investigated sharing practices of multiple devices and accounts amongst household members. Jacobs et al. discussed intentional and unintentional patterns in technology sharing of cohabiting couples [8], in a study on sharing of smart devices Matthews et al. identified *borrowing*, *mutual use*, *setup*, *helping*, *broadcasting*, and *accidental* as the primary reasons of mutual use [12], and Sun et al. focused on identifying specific challenges of watching YouTube videos together on devices including mobile phones, computers, tablets, and TVs [16]. Despite the presence of this extensive body of literature on shared use of devices such as phones, tablets, and computers, there is no published research on shared use of other IoT and voice-connected devices at this time.

1.2 Technology Use in Families

Technology is pervasive among American families and even younger children are active technology users. In fact, 75% of children under

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[1] https://www.nielsen.com/us/en/press-room/2018/nielsen-launches-new-mediatech-trender-survey-to-uncover-consumer-sentiment-on-emerging-technology.html

four own their own dedicated mobile device [9]. Previous work on parental mediation (the practice of overseeing a child's exposure to and use of technology) has categorized into three types: active mediation; where parents and children discuss and negotiate on usage, restrictive mediation; where parents set limits on use, and co-engagement; where parents and children consume content or interact with devices as a joint activity [17]. Parental mediation is a very well-studied topic in the HCI community (e.g., [7]). However, family practices that are established for using devices that are designed to be shared devices (e.g., smart speaker) and have voice input system, which creates the potential for young children to use features and access content that previously required the ability to read and write have not been studied before. Therefore, this paper also aims to explore how parents regulate and support children's shared use of smart speakers.

2 METHODOLOGY

Data for this paper emerged from a multi-methods study (comprising of diary study and semi-structured interviews) to investigate why and how people share IoT. For logging daily instances participants used the application named PACO [4]. PACO was configured to send three randomly generated reminders between 8 a.m. and 8 p.m daily for 8 weeks. Participants could also record any relevant event as soon as they observed or participated in one. In the diary study, participants were asked to log atleast 3 daily in-situ sharing instances in form of answers to the following questions for two weeks: Name of the device shared, location where the device was shared, relationship to the person with whom device was shared, purpose of sharing the device, and detailed log of the interaction with the device. After the diary study, in the interviews, we asked a list of open-ended questions such as what motivates them to share their smart devices, what are the challenges and constraints that they face, and how they coordinate shared use of devices. The interviews took 45 minutes on an average and were audio recorded and transcribed for the purpose of analysis. This study was approved by the Syracuse University Institutional Review Board.

In Phase 1, researchers individually developed the basic codes corresponding to the entries of diary study and interview transcripts of two participants. After that both authors worked together discussing and refining basic codes to reach high agreement (Cohen's Kappa 0.85). Basic codes were grouped together to identify categories using affinity diagrams. In second phase, each author coded half of the remaining diary study logs and interview transcripts using the code book developed in Phase 1. Authors met after coding data from each participant to discuss and refine the coding scheme. The data was analyzed on an ongoing basis, which not only improved our understanding of user preferences and sharing habits, but also helped us improve the probes that we used in future interviews. The results include data collected from 15 participants who shared smart assistants. Participants were compensated 30$ for their time.

3 PRELIMINARY FINDINGS

This section presents preliminary results comprising of overview of sharing and two influential factors that shape the sharing practices of smart speakers.

3.0.1 Overview of Sharing. In total 201 in-situ instances were logged by 15 participants (age: avg. 35, min. 30, max. 60; gender: 6 male, 9 female) with a median of 12 sharing instances over the period of 14 days. Participants reported following different types of sharing instances that they participated in during the diary study: (1) one-off events of sharing a device with somebody (e.g., visitors used the smart speaker to play music); 30 occurrences, (2) two or more people using a device iteratively (but independently) for different purposes (e.g., one person setting up a reminder in the middle of other person listening to an e-book); 101 occurrences, and (3) two or more people collaboratively using a device at the same time for a common purpose (e.g., for playing games, educating activities with children); 70 occurrences. The participants who shared devices in former two categories are referred to as 'sharers', and the participants who fall in last category and co-used the device are referred to as 'co-users' in this paper.

All participants shared their devices with their children (age: avg. 13, min. 5, max. 16; 61 sharing instances) and spouses/partners (70 sharing instances). Eight participants also shared devices with visitors (e.g., co-workers (24 sharing instances), friends (36 sharing instances), relatives (44 sharing instances)) to their house. It is important to note when participants shared/co-used the device with more than one person (e.g., children and spouse; relatives and spouse), we counted that instance with respect to each sharers/co-user involved in the event. Finally, 70 of the logged sharing events comprised of sharing the device in short bursts (e.g., to ask trivia question, listen to a song) that lasted between 30 seconds - 3 minutes, majority of the events comprised of sharing interactions that on an average lasted 21 minutes (min: 5 minutes, max: 30 minutes).

Participants used and shared smart speakers for entertainment purposes (e.g., listening to music, playing games, checking whether report, or asking trivia) or for assist functions (e.g., intercom-calling to other rooms in the house, hands-free phone calls and messages when hands were engaged in something else, controlling other devices, mnemonic for remembering things to be purchased, or accessing calendars of sharers). The various functionalities that smart speakers supported and their voice-enabled connectivity made sharing of smart speaker different than other household devices that are usually employed for one specific function (e.g., TVs, smart thermostat, smart lights). Furthermore, our findings reveal that user's understanding of device's capabilities or functionalities and their judgement of device's relevance in daily lives change with time, which in turn affects user's reasons and practices of sharing smart devices. For example, eight participants who had been using the device for more than six months, at the time when they participated in the study, used the device more because of the convenience that assist functions lended to their lives than using it for mere entertainment purposes.

Surprisingly many of our participants (7 out of 15) had multiple smart speakers and many of these participants (4 out of 7) had speakers from different companies. Such participants had clear demarcations and preferences in terms of the activities they performed on these devices. They reported that Google's smart speakers are more efficient in finding answers to complex questions as Google has a rich database of information, and Amazon's smart speakers are appropriate for accessing media (e.g., music or books).

3.0.2 Specifics of Sharing Devices with Children. Majority of our participants (10 out of 15) explained that, for children, interacting with smart speakers is mostly enjoyable, but is (1) limited to short durations, (2) carefully monitored either actively (by being physically present in the vicinity) or passively (by checking the logs every week) by the parents, and (3) based on the negotiations between parents and children regarding duration, time, and form of use (active mediation). Sometimes, parents even allowed their children to interact with the device as a reward for their good behavior.

Previous work by Sciuto et al. [15] has shown that while children start interacting with conversational agents at a very young age, children's verbal intonation and cadences make interacting with these agents a skill to be mastered. However, all the participants (5 out of 15) with 5-7 years old children, mentioned that despite these challenges their children are interested to interact with the devices because they perceive the speakers to be person-like to the point of befriending them. Diary logs explaining children's interactions with smart speakers personified the device using the name of the assistant (Google Now, Alexa, Siri) or person pronouns (e.g., she). But diary entries illustrating others' interactions with the device did not personify the device and used name of the device (Echo, Google Home) or object pronouns (e.g., it). When participants were pointed to this during the interviews, they believed that this was because the device sounded like a person to their children (e.g., device addressed everybody with their first names, the tone of the speaker was perceived to be that of a human) but for elder members of the family or visitors 'it was just a device.'

Therefore, four participants portrayed interactions with the speaker to be a 'game with a friend' to then teach their kids pronunciation of new words, spellings, or use the device to complete their homework (e.g., unit conversations or basic calculations). Participants also logged that they co-used smart speaker to play various kinds of educational games (e.g., strategy games, quizzes) with their children. During the interviews parents shared that they did so not only as a co-engaging activity but also expected the kid to develop various skills (e.g., deductive ability, ability to strategize) in the process.

Our study also revealed that parents modified their own or restricted other's interactions with the devices because of the apprehension or realization of being copied by children. For example, five of our participants recalled that they particularly do not use their smart speakers to order anything online because voice-based interaction makes it into a public activity, and children could learn, imitate, and even order things that parents would not approve of. Furthermore, 10 participants forbade every adult user of the device to access explicit content through speakers as children could hear and/or try to then access the content themselves.

3.0.3 The Impact of Not Understanding Smart Devices' Behavior on Shared Use. During the diary study, almost all participants indicated that they are not fully aware of the capabilities of smart speakers. This was primarily driven by their insufficient knowledge regarding (1) what and how the device was doing, (2) how and if the device was learning preferences of multiple users co-using it, and (3) what was the role of users in this process. Our further investigation of this issue, during the interviews, revealed that in many cases at least one of the devices' affordances (clues regarding possible operations on the devices [6, 10])) were not clear to the participants. Different kind of affordances that emerged during interviews were: Physical affordance (a design feature that enables performing an action), functional affordance (potential purpose/goal of a device), cognitive affordance (feature that supports thinking or knowing about an action possibility), and sensory affordance (a feature that helps user with their sensory actions and thereby supports physical and cognitive affordances, e.g., voice based information). This, thereby, also led the participants to not use the devices to their full potential because of the shared context.

Participants pointed out that the absence of a visual representation[2] of available functionalities (physical affordance) or inadequate feedback and information in terms of device's limits/capabilities (cognitive affordance) led them to not use some of the device's functionalities. Due to the lack of appropriate physical affordances many participants, for example, were unaware about the possibility to link multiple profiles/accounts to the device or securing functionality of purchasing with a passcode. While the former lead to the frustration of not being able to access personalized content as multiple people accessed content with the same account the latter lead to not using the functionality at all due to the fear of unwanted purchases by others (specifically children).

Five participants expressed that there is a lack of a possibility of granting granular control/ access levels (functional affordance) to their co-users/sharers (specially visitors and children) of their smart speakers. It is important to note that Amazon and Google provide detailed information on how to enable different access levels to multiple users on its support website. For example, with respect to Google Home one can link and restrict the content based on the voice of a user[3]. As a matter of fact, many of our participants did maintain different profiles or granted distinct access levels to their co-users, specifically children. However, the problem lies in the fact that a user has to purposely search for the information or read the documentation to understand any particular functionality, and the device explicitly or automatically does not convey such instructions.

4 DISCUSSION AND DESIGN IMPLICATIONS

Even though the results presented in this paper are preliminary and therefore have certain limitations our analysis highlighted following design implications:

(1) Employing Cognitive Affordances of Feedforward to Convey Possible User Actions and Device's Capabilities: Feedforward is meant to introduce and explain the purpose (functional affordance) of a device before a user performs an action [18]. We argue that designers need to employ feedforward to better convey capabilities of smart speakers. To recall, many a times, our participants were found to be unaware of many functionalities on their devices (e.g., securing the purchase functionalities or making multiple user profiles on smart assistants). In such a case, a well-defined set of instructions (readable or voice-enabled) either on the device itself or on an associated application could be used as a feedforward to reveal the different possible actions on the device.

[2]The study was conduced before Google Hub was released in the market and none of the participants owned Amazon Show

[3]https://support.google.com/googlehome/answer/7323910?hl=en

(2) Adapting Speakers for Young Children: It is critical for designers and manufacturers of smart speakers to understand and evaluate the impact voice-based interactions are having on children. As our diary logs and interviews showed, parents utilized the device as a learning aid for their children to develop various skills (e.g., deductive ability, ability to strategize). This was driven by the facts that smart speakers allowed for voice-based interactions (that do not require children to be able to read and write) and children perceived the device to have human-like qualities. We propose that speakers (and smart conversational assistants) should be adapted to better support younger children who currently struggle with voice-based interactions. For example, conversational assistants can provide feedback by paraphrasing incomplete or inaccurate sentences by children or provide suggestions to improve their commands (e.g., repeating the command at a slower pace)

5 CONCLUSION

As voice-connected devices are becoming increasingly common in our daily lives it is important to develop the understanding of how people use and share these devices in their daily lives. To this end we conducted a diary study for a period of 2 weeks. Our paper shows that smart speakers are frequently shared with strong and weak ties in various forms and under varying level of constraints. Based on our findings we propose design implications in terms of improving adaptability of such devices to better support children's use and providing better cognitive affordances. These findings have implications for the design of future IoT devices, which need to meet the needs of users more closely, thereby enabling long-term use.

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