"She'll just grab any device that's closer": A Study of Everyday Device & Account Sharing in Households

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ABSTRACT

Many technologies assume a single user will use an account or device. But account and device sharing situations (when 2+ people use a single device or account) may arise during everyday life. We present results from a multiple-methods study of device and account sharing practices among household members and their relations. Among our findings are that device and account sharing was common, and mobile phones were often shared despite being considered "personal" devices. Based on our study results, we organize sharing practices into a taxonomy of six sharing types—distinct patterns of what, why, and how people shared. We also present two themes that cut across sharing types: that (1) trust in sharees and (2) convenience highly influenced sharing practices. Based on these findings, we discuss implications for study and technology design.

Author Keywords

Device sharing; account sharing; household; CSCW; usable privacy and security; user study.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Many technologies rely on the assumption that they will be used by a single person. For example, personalization systems create a user model based on actions in a single signed-in account or device [33]. Also relying on this assumption are authentication solutions that keep users signed in across sessions, systems that offer to save passwords, OS-level authentication that grants access to an entire device, and systems that auto-backup to cloud accounts.

However, the 'single user' assumption may not consider the many account and device sharing situations that arise during everyday life. For this paper, we define *sharing* as any situation in which two or more people use a single device or account, either at the same time or taking turns. A common sharing scenario revealed in the study presented in this paper involved household members borrowing each others' mobile phones. They would do a quick web search or play a game with whoever's phone was closest, available (e.g., not out of batteries or in use), and had the desired content or capability (e.g., the right game). Other examples abound: kids watch videos on a parent's account, friends navigate maps using each others' phones in the car, one spouse sets up a device on behalf of the other, a family uses a single desktop computer at home, and so on.

In sharing situations like these, systems designed for a single user can break down. For example, personalization systems may surface inconsistencies or private activities if they incorporate the actions of others into their models [1,33]. Password management systems may save the credentials of a sharee on the sharer's account or grant a sharee access to a sharer's accounts. Authentication systems that keep users logged in across sessions may enable a sharee unexpected access to a sharer's accounts.

Prior work has shown that people share devices [8,9,14,18,19,24,25,31] and accounts [3,11,15,30], but we lack a systematic understanding of the nature of device and account sharing, across multiple device and account types, in households today. This understanding is critical to our ability to design systems that consider everyday device and account sharing practices. Further, this understanding could inspire novel systems that better support the realities of how people share technology.

We present results from a multiple-methods study of device and account sharing practices among household members and their relations, and discuss implications for design. Our study involved (1) a survey of 99 households about their devices; (2) a 21-day diary study with 25 participants to collect in situ device sharing instances about phones, tablets, and computers; and (3) interviews with 24 participants about why and how device and account sharing occurred. We address the following research questions:

- What devices and accounts are shared? With whom? Why? With what frequency? To do what activities? Using what security measures?

- What are implications of device and account sharing for study and technology design?

Among our key findings are that device and account sharing is common, and that mobile phones were shared as much as computers and more often than tablets—even though participants typically perceived phones as *personal* devices and did not realize how often they were shared until participating in our diary study. Technology sharing was messy, varied, and frequent. Thus, *the major contribution of this work is a taxonomy of six sharing types*—distinct patterns of what, why, and how people shared their devices and accounts—developed from our study results. We found that sharing was often intentional, but sometimes accidental or unsupervised sharing occurred. We also present two themes that cut across sharing types: that (1) trust in sharees and (2) convenience highly influenced sharing practices. Based on these empirical findings, we discuss implications for designing studies and technologies.

RELATED WORK

We focus on everyday sharing of *common devices and accounts* among household members and their relations. This excludes prior research on sharing *content* in which each user authenticates to their own account (e.g., sharing photos [22], files [29] across accounts), as well as *specialized multi-user devices or accounts* designed for specific use cases (e.g., tabletop [23] or whiteboard [26] displays, or specialized calendars [7]). Given this focus, we scope this section to prior research on sharing of common devices (phones, tablets, computers) and accounts (email, social, financial, etc.). We discuss prior studies of device and account sharing, what influences sharing, and security and privacy practices when sharing.

Studies Documenting Device and Account Sharing

The fact that *people share common devices* has been documented [6,8,9,14,18,19,24,25,31], though most studies have focused on practices around a single device (e.g., mobile phones *or* tablets). Some studies have shown that mobile phone sharing is common [6,9,19], especially in developing countries [18,25,31]. Based on an ethnographic study in Bangalore, Steenson and Donner [31] described two categories of sharing: *proximate* (multiple close relations use a single phone) and *distributed* (person A will call person B to reach person C, who may not have a phone). Karlson et al. [19] documented how often 12 U.S. participants shared their phones, based on their recall during interviews. Research on tablet use has found that for some activities—playing games, reading books, educational work—multiple family members will use a device together [24]. Bødker and Christiansen [6] interviewed 12 early mobile phone users and noted ad hoc sharing with family and friends. Frohlich and Kraut [14] conducted an early study on in-home technology use and found participants using the computer together for entertainment and parents logging into their children's accounts to monitor activity.

Fewer studies have explored *sharing behaviors across multiple common devices*. Based on visits to 15 households in the U.S., Brush and Inkpen [8] found that family members shared a range of technologies, though computers were shared more often than mobile phones. They also found that sharing occurred more frequently with devices located in public spaces within the home.

Some work has explored *account sharing* [3,11,15,30]—that is, when two or more people use the same credentials for a single account. Egelman et al. [11] studied computer OS-level profile use in families and found that family members frequently used each others' profiles. In a study of home network use, Grinter et al. [15] found that when Tivo viewer profiles were not used as intended, personalization was affected. Alghamdi et al. [3] and Singh et al. [30] studied bank account sharing, finding that it was motivated in part by the sharers needing help from the sharees.

Sharing Influencers

Prior studies have identified factors that influence sharing, including *trust* [3,8,10,16,21,27,30,31,34], *culture* [3,4,31], and *utility* [10,12,16–18,25,31].

People often share based on the trust they have in the sharee or the dictates of their culture. Brush and Inkpen [8] found that trust between family members was evident in the extent of open sharing that occurred, though this did not always extend to parent-child relationships. In a survey of people in Vancouver, Cherapau et al. [10] found that respondents often shared their phone passcodes with people they trusted. Steenson and Donner [31] found that phone sharing practices in Bangalore often involved family members, friends, and nearby neighbors, to the extent that it was common to call one person's phone to reach somebody else. Alghamdi et al. [3] studied couples in Saudi Arabia, finding that bank credentials were not only shared or withheld as a sign of trust, but also because sharing fit within the cultural expectations of spousal access. In a study of Australian participants, Singh et al. [30] found that couples shared internet banking passwords as a sign of trust.

Utility and convenience are other strong influencers: people share because it is useful or easy. In some socio-economic situations, technology sharing is essential due to limited resources [18,25,31]. Prior work in the U.S. and Europe describes sharing as 'spontaneous' [16,19] and motivated by quick access to digital content [16]. This work suggests that people weigh the potential cost of sharing a device (loss of privacy/security or a temporary inability to access one's technology) with the usefulness of sharing [10,12,16,17]. Frohlich and Kraut [14] found that within a household, convenience was a frequent motivator for sharing when performing quick information-seeking tasks.

Security and Privacy When Sharing

Sharing common devices and accounts may make the sharer's data or online activities accessible to the sharee, and vice versa. Prior research has explored how people regulate

access to sensitive data when sharing their devices [16,17,19,21] and technology solutions that aim to make sharing more secure or easier [5,8,11,17,20,28].

Sharers sometimes attempt to regulate sharees' access to data. Karlson et al. [19] interviewed 12 U.S. mobile phone users about what data they were comfortable sharing and why, suggesting an all-or-nothing sharing model is not sufficient to meet user needs. Mazurek et al. [21] interviewed 33 Pittsburgh-based participants about how they controlled access to digital content within their households. Sharers described deleting or hiding sensitive data, using device-level PINs or passwords, mandatory supervision during sharing, or refusal to share with certain individuals. In a study of smartphone sharing, Hang et al. [16] similarly found that participants reported staying in proximity to the sharee or refusing to share with those they did not trust.

Profile switching is a commonly proposed solution to handle many issues that arise when sharing, including mitigating privacy and security risks. However, prior work has shown that the cost (in time and mental effort) of switching profiles is often too high [5,8,11]. Brush and Inkpen [8] and Egelman et al. [11] found that even families who set up and intended to use profiles often did not.

Authentication solutions have been proposed to provide more control in ad hoc sharing situations, something studies of technology sharing have found participants want [16,17,19]. Hayashi et al. [17] introduced authentication mechanisms that would provide limited access in situ, including allowing sharers to lock access to all but the current active application. Liu et al. [20] proposed xShare, which allows users to set custom access controls right before sharing. Seifert et al. [28] proposed TreasurePhone, which uses context to automatically add access controls.

Our work adds new knowledge to this literature. We use a multiple methods to study device and account sharing within a variety of household types, including those with roommates, childless couples, and adult children living with their parents. We describe the six *types of sharing* we observed (e.g., *borrowing*, *mutual use*, etc.), and for each type, discuss what is shared, why it is shared, how it is shared, how often this type of sharing happens, and what activities are usually performed. This novel taxonomy gives designers a range of concrete sharing types to inform their technology. While prior studies cover themes about sharing, none have systematically organized and described the range of sharing behavior types for designers. We also expand on the roles of trust and convenience in device and account sharing.

METHOD
Our study, conducted between June and September 2014, involved (1) an inventory survey of 99 households about their devices; (2) a 21-day diary study with 25 participants to collect in situ device sharing instances; and (3) interviews with 24 participants about why and how device and account sharing occurred. We provide details below.

Participants
Our participants were English speakers in the U.S. Each participant responded on behalf of their household, which we categorized into one of 6 arrangements:

1. Lives only w/significant other (N=25 for the survey, N=3 for the diary and interviews)
2. Lives w/kids <13 years old (22 survey, 6 diary, 5 int.)
3. Lives w/kids 13-18 (16 survey, 4 diary/int.)
4. Lives w/kids under *and* over 13 (6 survey, 1 diary/int.)
5. Lives only w/nonrelated others (16 survey, 6 diary/int.)
6. Miscellaneous (e.g., adult living with parents, lives with children + roommates) (14 survey, 5 diary/int.)

Participants were recruited via our institution's external participant database and sent a screening survey via email. An incentive was provided for participating.

The *99 survey participants* included 44 females, 54 males, 1 unspecified; 11 age 18-22, 25 age 23-39, 22 age 30-39, 27 age 40-49, 11 age 50-59, 3 age 60+; and 59 were employed, 8 unemployed, 19 students, 13 other. The *25 diary study participants* included 13 females, 12 males; 2 age 18-22, 8 age 23-39, 8 age 30-39, 3 age 40-49, 4 age 50-59+; and 16 were employed, 3 unemployed, 2 were students, 3 other. The *24 interview participants* were the same as the diary study with one fewer female age 23-39. Occupations of participants varied, including law clerk, broker, teacher, administrate assistant, pastor, and small business owner.

Device Inventory Survey
Based on responses from the screening survey, we invited 120 English-speaking people who used a mobile phone *and* desktop or laptop computer at least once per month to participate. We sent invitees a paper-based device inventory survey packet that included a welcome note, instructions, household member survey (who lives in the household), device inventory survey (what devices are in the household, for what they are used, and who uses them), and a return envelope with pre-paid postage. We received completed packets from 99 respondents in 34 states.

Diary Study on Device Sharing
We selected 25 of our 99 survey respondents, from 17 U.S. states, to participate in the follow-up diary study. Since we were interested in learning about device sharing, we selected respondents from the inventory survey who reported that they and at least one other household member used the same mobile phone, tablet/e-reader, or laptop/desktop computer at least once per month. All participant households had at least one of each device type, except one household that had no tablet/e-reader. The diary was conducted via the PACO smartphone app [13], which required that participants use a smartphone running iOS 7+ or Android 2.2+.

Participants were notified 3 times a day for 21 days to report instances of device sharing they observed, defined as 2+ people using the same mobile phone, tablet/e-reader, or laptop/desktop computer, either one after another or together. Notifications asked if participants had seen any sharing

recently. If they indicated that there was a recent example of sharing, we asked them what device was shared (select one type), whether the individuals used the device at the *same time* or *one after another*, who the individuals were (select one or more relationship types). Participants could also submit responses if they observed a sharing instance but did not have an active notification. In total, 25 participants reported 591 in situ instances of sharing over 21 days, 445 of which were in response to a notification. (These numbers exclude 14 reported sharing instances we deemed outside the study's scope of sharing among household members and their relations, e.g., observing two strangers share a library computer or a computer in the Apple Store.)

Interviews on Device & Account Sharing

Finally, we conducted 1-hour long, semi-structured one-on-one phone interviews with 24 of the diary study participants to further explore device and account sharing. Interview questions focused on mobile phones, tablets/e-readers, and laptop/desktop computers. In cases where participants spontaneously discussed account sharing—which happened for all participants—we explored how and why *accounts* were shared, and included those findings in our results. Interviews were audio recorded and transcribed for analysis.

Piloting

We conducted multiple rounds of pilot testing to ensure the high quality of our data. Participants for all pilot studies were colleagues at our institution. Based on feedback from piloting, we converted the inventory survey from digital to paper form and improved the structure and clarity of questions in the survey, diary, and interviews.

Analysis

From the inventory survey, we calculated descriptive statistics such as the average number of devices per household. From the diary study, we calculated descriptive statistics such as the average percentage of sharing instances reported per participant, broken down by device type and with whom devices were shared. Where we report significant differences below, we include details on the statistics used.

To analyze the interview data, we used a general inductive approach [32]. All transcripts were read by three of the authors who collaboratively developed a coding scheme that focused on characterizing device and account sharing practices, as guided by the research questions. The three researchers each coded one-third of the transcripts, meeting after each new transcript was completed to discuss and refine the coding scheme. Early in our analysis, we realized the importance of coding attributes of *sharing stories* participants described. A sharing story was any time a participant described sharing a single device or account, for example a phone or a bank account. From this analysis emerged 228 *sharing stories*. In this paper, we focus on the following attributes of sharing stories:

- **What**: phone, tablet, computer, or account type (e.g., entertainment, email, bank, etc.)

- **Why**: reasons for sharing, such as convenience, helping someone, and so on.
- **How**: any security measures or social norms involved in the sharing, such as staying nearby to monitor use, using together, and so on.
- **Frequency**: once, rarely, sometimes, often.
- **Activities**: entertainment (watching videos, listening to music, playing games), messaging, browsing the Internet, installing an app, and so on.

We observed common patterns of the *why*, *how*, and *frequency* attributes that distinguished the sharing stories. A final analysis pass organized the 228 sharing stories into the *types* in Table 1 based on patterns of the *why*, *how*, and *frequency* attributes. Sub-sections in Results describe each *sharing type* in turn, their attributes, and how they are distinguished from other types.

Limitations

Our study is subject to some limitations. We relied on self-report data, which is subject to biases such as social desirability and recall. Regarding sampling, our participants are not necessarily representative of the U.S. population. Furthermore, they were willing to speak with us about their households and technology use; those unwilling to do so may have characteristics or issues we did not discover. Also, the numbers we present should be interpreted carefully. We include them to indicate broad trends from our study, not to represent sharing practices within a broader population. This is particularly true for the numbers associated with interview data, as the interviews depended on what participants remembered and chose to discuss. To minimize recall bias in interviews, we asked about devices and sharing instances reported during the inventory survey and diary study. However, participants discussed *accounts* in a more ad hoc manner. Also, we had not developed our full set of attributes and codes until the analysis phase, so follow up questions were not asked to fully explore all attributes of each sharing story. Thus the numbers associated with account sharing and to characterize the frequency of different sharing story attributes should be interpreted with caution.

RESULTS

We begin with results from the diary study and inventory survey; key findings are that (1) device and account sharing are common, and (2) mobile phones were frequently reported as shared. Next, we present a taxonomy of sharing types—patterns of what, why, and how people shared—developed from our interview results. Finally, we present two themes that cut across sharing types: that (1) trust in sharees and (2) convenience highly influenced sharing.

Diary & Inventory: Overview of Devices and Sharing

Diary study participants reported sharing instances that they participated in and that they observed others participating in without being involved themselves. Averaging all of these sharing instances per participant, the main findings from our diary study were that device sharing was common (with a median 14 sharing instances per participant over the 21-
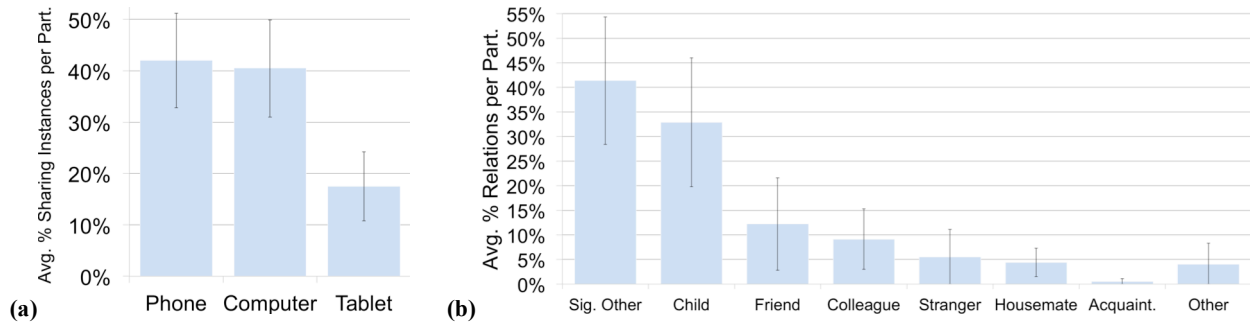
Figure 1. Diary study results. (a) Sharing by device, shown as the average percent of sharing instances per participant (591 total instances reported by 25 participants). (b) Who participants shared with, shown as the average percent of relations reported per participant (533 total relations reported by 25 participants during 468 sharing instances; 1 relation listed in 413 instances, >1 relation listed in 55 instances). Sig. others and children were most common relations shared with. Error bars represent 95% CIs.

day study period), and mobile phones were shared as often as computers and more often than tablets (phones were shared significantly more than tablets, $t(43.91)=4.22$, $p<.001$, as were computers, $t(43.26)=3.88$, $p=.001$, according to pairwise t-tests, corrected for multiple tests using the Bonferroni method). Of the 591 sharing instances reported in the diary study, an average of 42.0% per participant involved phones, 40.5% involved computers and 17.5% involved tablets (Figure 1a). Our *inventory survey*, for just the 25 participants who also completed the diary study, revealed that participants' households contained fewer mobile phones (3.0 average per household) than computers (4.0 average per household), so the extensive sharing of phones is notable. The *inventory survey* indicates that more participants (100% of 25 diary study participants) reported someone in their household *using* at least one household phone and computer on a weekly basis, and fewer (88%) reported weekly usage of at least one household tablet. Thus sharing and usage patterns may roughly align.

To examine the *relations* participants shared with, we analyzed the subset of diary study sharing instances in which the participant was involved (468 out of 591 total sharing instances). Restricting the data in this way was important to ensuring a consistent point of reference (the participant) for defining the relationship type (e.g., the participant's children, friends, etc.). Overall, participants shared most often with their significant others and children (see Figure 1b; significant according to one sample, two-sided t-tests of the null hypothesis that all relation types are equally likely, corrected for multiple tests using the Bonferroni method; significant others $t(23)=4.37$, $p=.0018$ and children $t(23)=3.06$, $p=.045$).

An interesting finding from triangulating our diary study, inventory survey, and interviews was that sharing was often invisible to participants. In the inventory survey (prior to the diary study), we asked participants to self-report which of their devices were shared with one or more others at least once per month. Then in the diary study, we asked them to report each sharing instance that they participated in or observed in situ. A priori, they reported that more tablets were shared (34.5%) and computers were shared (31.8%) than

were phones (27.6%). However, the average amount of sharing they reported in situ was higher for phones and computers than for tablets (Figure 1a). While these two metrics do not contradict (since they are not directly comparable), it was not until the in situ exercise that participants *realized* the prevalence of phone sharing. Multiple participants expressed their surprise in interviews at learning from the diary study how often they shared devices they had previously thought of as personal:

"We weren't really paying attention how much of [my wife's and my phones] [our kids] were using… Every time the app called for making the survey, my kids were always involved." (P20)

Taxonomy of Sharing Types

From our survey and diary study, we learned that device sharing occurred frequently. From our subsequent interviews, we learned that technology sharing was messy and highly varied. It was messy in that participants did not share their devices and accounts the same way with every person or in every situation. It was varied, in that our initial definition of sharing as 'more than one person using a device or account' was too simple to characterize the many ways and reasons participants shared. Through our analysis of interview data, we discovered that there were distinct patterns of what, why, how, and how often participants shared devices and accounts, which we call *sharing types*. What follows is a taxonomy of six sharing types that occurred in the households studied: *borrowing*, *mutual use*, *setup*, *helping*, *broadcasting*, and *accidental* (see Table 1 for an overview).

Borrowing

The most common sharing type described was *borrowing*, an ad hoc, temporary lending of a device or account to benefit the sharee (all 24 participants reported *borrowing*, which accounted for 47% of sharing stories). Example sharing stories of the *borrowing* type include:

Friends Sharing PINs: Lisa[1] sometimes uses her friends' phones when out. She usually uses their phone browser to check her accounts, but occasionally uses apps, if they are easy to set up. Some friends have told her their phone passcodes. (P6)

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[1] Pseudonyms are used throughout the paper.

Sharing Type	Description *Applies to devices and accounts*	# (%) Sharing Stories (N=228)	% Ps
Borrowing	Temporary lending that benefits the sharee	107 (47%)	100%
Mutual Use	2+ people regularly use device/account as one of their primary of that type	48 (21%)	75%
Setup	Sharee sets up device/account on behalf of sharer	26 (11%)	58%
Helping	Sharee helps sharer do a task other than setup	16 (7%)	46%
Broadcasting	2+ people view a device/account at same time	10 (4%)	29%
Accidental	Unintentional access of data while sharing device/account	21 (9%)	42%

Table 1. Taxonomy of 6 sharing types—distinct patterns of what, why, how, and how frequently participants shared their devices and accounts—identified from interview data.

Out of Batteries: Everyone in the Chang family has their own tablet, but sometimes one of the kids will forget to charge theirs, so they borrow someone else's. (P22)

Attributes

What: Phones were a commonly borrowed device (47% of sharing stories), followed by computers (30%), then tablets (16%). Accounts were rarely borrowed—it did not tend to make sense to temporarily borrow someone's email account, whereas it did sometimes make sense to borrow another's phone to sign in to one's own email account.

Why: There were three main motivations for *borrowing*: *convenience*, *content*, and *capabilities*. The "out of batteries" story above is an example of *convenience*—rather than wait for one's own tablet battery to charge, it is more convenient to use someone else's tablet. Participants commonly borrowed someone else's device if it was more conveniently located than their own, as described by P20:

"We're watching TV and my phone is more handy than [my wife's] phone, and she'll grab my phone and start Facebooking or playing [a game]... She'll just grab any device that's closer to her. Same with me. If I need to make a call and her phone is next to me, I'll grab her phone."

The *capabilities* of or *content* available on a device were also important rationales for *borrowing*, such as a child playing a particular game on her parent's tablet or a spouse *borrowing* a phone for its better camera:

"[My wife] likes the camera on my phone better, so sometimes she'll use it for those purposes." (P24)

How: A mixture of security approaches were used for *borrowing*, reacting to a range of trusted to untrusted sharees. In 60% of sharing stories, participants described trusting the sharee and allowing them full, unsupervised access. For the remaining 40%, participants described limited trust in the sharee, allowing supervised use after entering credentials themselves. P16 described sharing with a trusted daughter:

"[My kids] usually take my phone and I don't really pay too much attention to what they're doing on it. Last night my daughter took my phone to video chat with a friend."

Frequency: *Borrowing* was characterized by happening at ad hoc occasions. *Borrowing* frequency was idiosyncratic by participant, ranging from rare to often. However, borrowers usually had their own device of the same type they were *borrowing*, so there was an expectation that they would limit the amount of time they borrowed.

Activities: The top activities done on borrowed devices were entertainment, social/messaging, and web browsing.

Mutual Use

The next most common sharing type was *mutual use*, when 2 or more people regularly used a device or account as one of their primary of that type (75% of participants, 21% of sharing stories). Unlike the other sharing types, *mutual use* often did not involve a sharer and sharee, but rather two (or more) people who had fairly equal ownership of a device or account. Example *sharing stories* of *mutual use* include:

Shared Netflix Account: The Martinez family mutually use one Netflix account. It has one profile for the parents and one kid-specific profile for the two kids. The family's devices have PINs to prevent the kids from using them without permission, but once the device is unlocked, they can freely access Netflix. (P19)

Family Computers: The Smith's (Mom, Dad, 13 y/o Daughter) have 2 shared desktop computers: upstairs and downstairs. Mom only uses the downstairs computer. Dad and Daughter use whichever is most convenient. The downstairs computer has 3 Chrome browser profiles (one per person), and the upstairs computer has 2 Chrome browser profiles (for Dad and Daughter). They mostly use their own profiles, but sometimes forget to log out and will use each others'. (P17)

Attributes

What: 37% of *mutual use* sharing stories were about computers or tablets and 63% were about accounts. No phones were mutually used—a result that might be different in other countries [18,25,31]. The lack of mutually used phones may have contributed to perceptions of phones as "personal" devices (we return to this in the Discussion). The most common *mutually used* accounts were entertainment focused (TV, video, music, and games), representing half of the account sharing stories for this type. The other half were often critical household accounts, like a couple's bank account or family calendar.

Why: The three main drivers of *mutual use* were *mutual need*, *limited resources*, and *convenience*. For example, spouses often mix finances and thus *mutually need* a shared bank account. *Limited resources*, such as the money to purchase an extra device or subscription-based account, also led to sharing. Finally, *convenience* motivated the Smith family (in the story above) to keep two mutually used com-

puters—upstairs and downstairs—so they would not have to walk far to get to one. Sometimes these motivations combined: for example, participants demonstrated a strong desire for household-wide entertainment accounts, both for convenience (e.g., it was easier to maintain one music library) and to avoid multiple subscription fees.

How: For most of the *mutual use* stories (81%), participants shared with trusted others and all knew the authentication credentials for the device or account. Participants of six households described "common passwords" known by all household members so anyone could easily access household-wide mutually used devices and accounts:

> *"I think all families kind of have a couple of passwords that they use… So it's just kind of like a guess-which-one-it-is and you're probably going to be right." (P7)*

In 23% of stories, participants described setting up profiles (e.g., OS-level profiles on a desktop or browser profiles on any device); each user usually knew only their own credentials, but sometimes they knew each others'. As illustrated in the "family computers" story above, several participants described using the profile of whoever was logged in. As we discuss in the *accidental* sharing type below, unintentional access to data was often caused by not logging out of accounts or profiles on mutually used devices.

Frequency: For mutual users, sharing occurred often, and typically no one user got consistent priority over others.

Activities: A wide variety of computing activities were performed on/with mutually used devices and accounts.

Setup

The *setup* sharing type involved a sharee performing device or account initialization or major maintenance / configuration activities on behalf of the sharer (58% of participants, 11% of sharing stories).

> *The Family Sysadmin: Maya set up both of her parents' phones because they aren't very tech literate. She made the decision to not put a passcode on their devices, because she says they mainly use their phones for calling. She also set up their email accounts, so she knows how to get into those accounts. (P11)*

> *Phone Favor: Jake sets up cool new apps he discovers on his girlfriend's phone, because they are both early adopters. (P23)*

Attributes
What: More of the *setup* sharing stories were about devices rather than accounts (69% of stories for devices, with a fairly even mix of phones, tablets, and computers, compared to 31% of stories for accounts). Most accounts set up by a sharee included critical or sensitive information, such as bank, password manager, and email accounts.

Why: Almost all *setup* stories occurred because the sharer did not know how to initialize or maintain their device or account. We may have seen so many sensitive accounts set up by others because these are critical accounts most people need, even if they do not know how to set them up. The remaining *setup* stories occurred as a favor to the sharee.

How: In 81% of *setup* stories, the sharee retained full access to the device or account. They usually set up credentials, which sharers with low tech know-how often didn't change.

Frequency: The *setup* type was nearly always rare or one-time. However, the potential consequences of a sharee configuring and having continued access to a sharer's device or account was long-term.

Activities: Device or account initialization accounted for most of the *setup* stories (88%), followed by app installation without an account initialization, and factory resets to enable an ownership change.

Five of the 24 participants reported transferring a device to another person (usually their child) *without* removing their own accounts. Participants did not always factory reset these "hand-me-down" devices for the next owner, in part due to trusted relationships. Thus, participants described a variety of problems, from botched personalization (for themselves as well as for the new device owner) to accidental access to others' files or communication:

> *Reusing a Tablet: Dan gave his iPad to his son. Dan had originally set it up with his Google work account which is synced across all his devices. As a result, his son's Google-related activity on the iPad—which is often watching YouTube videos— shows up on all of Dan's devices. (P21)*

> *Hand-me-down Phone: Jen's daughter, Rose, uses Jen's old iPhone. Jen keeps her Apple account on the phone. When Rose takes photos, they show up in Jen's photostream, which Jen finds annoying. (P3)*

Helping

In the *helping* sharing type, the sharee uses the sharer's device or account to help the sharer with a task other than setup (46% of participants, 7% of sharing stories).

> *Busy Driving: Lisa and her boyfriend, Rick, use each others' phones in the car, getting directions, or texting. For example, if she gets a text message in the car, she'll ask Rick to read it. (P6)*

> *Setup then Help: Maya's dad doesn't use the computer. He asks Maya to do banking tasks on his behalf in his online banking account (which Maya also set up and has full access to). (P11)*

Attributes
What: For *helping* stories, 63% involved devices (mostly phones) and 37% involved accounts (a variety, including password managers, bank, and email).

Why: There were two main reasons for sharing by *helping*: (1) the sharer was indisposed or would be inconvenienced by using technology at that moment (as in the "busy driving" story above), or (2) the sharer did not know how to do the task (as in the "setup then help" example above).

How: In 75% of stories about *helping*, the sharee had full access to the device or account, and in nearly all stories, the sharee was described as a trusted individual.

Frequency: *Helping* occurred from often to rare, depending on the activity. For example, taking an ad hoc photo for a

friend may be a fairly infrequent activity, but backing up the photos on a spouse's various devices may occur often.

Activities: Sharees helped with a range of activities for the sharer including: in-car navigation, answering calls or texts, taking photos, backing up devices, creating calendar entries or emails, doing online banking, and managing passwords.

Broadcasting

For *broadcasting*, two or more people viewed the same device or account at the same time, usually to enjoy content together (29% of participants, 4% of sharing stories).

> *Viewing Content: Sometimes Mike's daughter will show him a music video that she's watching on her phone. Or, his wife will ask for his opinion on a chat message or email by showing it to him on the phone or tablet screen. He says, "I mean if we're sharing things we'll share it using our own device. My daughter will say, 'Can I show you this music video?' She'll bring the phone over rather than sending a link." (P17)*

> *Enjoying Media Together: When Jake has friends over, they like to watch movies or play music together. Someone will stream content from their phone or computer for all to enjoy. (P23)*

Attributes
What: Despite their small screens, phones were commonly used for *broadcasting* (40% of *broadcasting* stories). Participants explained that their phones were always with them, and they enjoyed a great deal of content on their phones—some of which they wanted to share. The remaining 60% of *broadcasting* stories were fairly evenly split between tablets and computers.

Why: The predominant motivation for *broadcasting* was to enjoy content with others.

How: Participants usually *broadcasted* with sharees they trusted, so they seldom voiced concerns about security. Further, in 60% of *broadcasting* stories, participants described the sharee(s) as viewing the content only, and in 20% of stories, the sharee interacted only briefly with the device or account. A methodological note is important here: the wording of our interview question ("Tell us about when someone else used your device/account, or you used their device/account") may have caused participants to underestimate *broadcasting*, since the sharer often retained control.

Frequency: Despite relatively few *broadcasting* stories (compared to the other types), participants described these events as occurring frequently.

Activities: Common activities included watching videos, viewing photos, playing games, listening to music, and reading messages or articles.

Accidental

The *accidental* sharing type is substantially different from the others. It involved the sharee gaining access to the sharer's device or account (and hence the associated data), when the sharer *did not intend* for that access to happen (42% of participants, 9% of sharing stories).

> *Shared Work Computer: Dan and Matt are coworkers who share a computer at work and log in with different accounts. Dan has accidentally seen Matt's email and files when Matt has forgotten to log out. Dan usually just logs Matt out. Dan has heard of other coworkers who share a computer accidentally emailing from the wrong account before, saying: "Not that I think anyone's doing anything maliciously, but you don't want somebody else to be sending email even accidentally from my email account to their customer saying, 'Send me your financial data.' That's not a good idea." (P21)*

> *Spying: A Chromebook is mutually used by Mom and teenage Daughter because Daughter's laptop died part way through the school year. Each has their own Google account, and they usually log in/out between sessions, but not always. Sometimes they browse the web in each others' accounts. When her daughter forgets to log out, Mom looks through Daughter's browsing history to see what Daughter has been doing online. Mom is not sure if Daughter knows Mom looks. Mom uses LastPass on the Chromebook, so Daughter could get into Mom's accounts (including bank), but Mom doesn't worry about it. (P2)*

Attributes
What: All *accidental* sharing stories were about *accounts* being unintentionally accessed during an otherwise intended device sharing situation. Most stories (62%) involved communication accounts (social, email, and texting). Several (19%) were work accounts accidentally being shared—some participants described mutually using computers at work, which sometimes led to *accidental* account accesses.

Why: As noted, this sharing type usually involved an intended device sharing situation that led to *accidental* account sharing. In 57% of *accidental* stories, the sharee was *borrowing* the device, and in 29% the sharee was *mutually using* the device—for both types, the first user had not logged out of the accounts that were accidentally shared.

How: Problematically, in 57% of *accidental* stories, participants described the sharee who gained access to their account as someone they did not fully trust.

Frequency: The frequency of *accidental* sharing is unclear. Participants sometimes became aware of these accidents or admitted to accessing others' accounts (e.g., see the "Spying" story above). However, a limitation of our method is that participants were unable to report what they did not know, or they may have avoided admitting they looked at others' accounts.

Influences on Sharing Behaviors & Security Decisions
The sharing types taxonomy adds structure and detail to our understanding of how participants shared devices and accounts. Across sharing types, two major themes emerged from the interviews: that motivation to share and security-related decisions were highly influenced by (1) trust in sharees and (2) convenience. These themes were so prevalent that they are an essential part of understanding everyday sharing. While prior work has identified trust [3,8,10,16,21,27,30,31,34] and convenience [10,12,16–18,25,31] as factors that influence technology sharing, our results add detail on how they influence the different shar-

ing types differently, and the effects of trust- and convenience-based sharing decisions (e.g., leaving participants open to security threats from trusted relations, or *accidental* sharing due to not logging out of accounts before sharing a device).

Trust in Sharees

Trust in sharees, which is often invisible to technology designers, highly influenced *whether* and *how* people shared devices and accounts. In more than half of sharing stories, participants described behaviors that implicitly communicated their trust in sharees (e.g., not supervising the sharee's use of a device) and in many of these, they explicitly described trust as impacting whether and how they shared.

A sharer's level of trust in a sharee strongly influenced the *level of security* the sharer enforced. Sharers used fewer security precautions to share with trusted sharees: the sharer would often give their password to the sharee and would not supervise use of the device or account. Significant others were nearly always described as a trusted sharee in interviews, corroborated by diary study data, which shows them as one of the most shared with relationship types (Figure 1b). P6 described open sharing with her spouse:

> *"I think the trust is a big factor, in any relationship so if you're comfortable with someone seeing your messages and you don't have anything to hide, like, there's no reason to have to keep logging in and out." (P6)*

Conversely, sharers used more security precautions with less trusted sharees: they either kept the device in their possession or supervised the sharee; applied rules (such as requiring the sharee to ask permission to use a device or account); and rather than giving their password to the sharee, the sharer would enter it themselves. For example, P23 gave his password to his girlfriend, but did not give it to visitors to his home who he let use his computer:

> *"[Visitors] definitely use my profile to do stuff… I have no problem letting people use it, like if I'm around and it's already open… I do wanna keep my password to myself." (P23)*

Because sharing practices implicitly communicated a sharer's trust in a sharee, participants sometimes felt obligated to share more openly than they may have felt comfortable with, in order to avoid communicating a lack of trust that could harm a relationship. For example, P14 described how building a relationship with his new wife took precedence:

> *"We've only been married two years… and we're just trying to figure out how to share things at this point, let alone worrying about sharing too much."*

Trust was based on past experiences with and expectations of the sharee's behavior. For example, P6 trusted her spouse with her phone or laptop, but did not trust her mom:

> *"[My parents are] just, like, very curious people. They want to know everything that's going on in my life, so I just know that they will, if given the opportunity, typically my mother, like, want to check my messages and stuff."*

Because it was experience-based, security decisions based on trust were dynamic and reactive. If a trusted person broke expectations (e.g., by snooping or pranking), they would become less trusted and sharers would change how they shared with that individual. Thus, social role (e.g., spouse, child, friend) was not necessarily a predictor of trust—it was possible that one participant would trust their significant other and another would not, or that a parent would trust one of their children but not their other child. Also, making security decisions based on trust left people open to harm from their social relations. In other words, trusted people could become potential threats. For example, P24 described why he put a password on his laptop:

> *"[My roommates] kept putting weird files and images onto my laptop when I wasn't there, so I was like, 'All right, we need to draw some boundaries here.'" (P24)*

Convenience

For over a third of sharing stories in interviews, participants described that *convenience* motivated *why* or *how* they shared. It motivated many of the *helping* and *borrowing* stories. For example, it is inconvenient to pull over while driving to answer the phone, so a passenger may answer it (*helping*). Likewise, it is more convenient to borrow your sibling's tablet if yours is out of batteries (*borrowing*).

For devices, their proximity to the sharee or location in the home was a major sub-theme that affected sharing. Devices that were located *nearby*, were simply more convenient to use. In a *borrowing* example from above, P20 noted that his wife will, "*just grab any device that's closer to her.*"

Not surprisingly, phones tended to be located nearby, which helps explain the diary study finding that phones were more frequently shared than tablets—they were often closer than tablets. P18 describes sharing his phone more than his tablet with his son, because "*I have my phone with me when I'm with [my son], when we're out… more often.*"

The desire for convenience also affected the adoption of security features, which led to many *accidental* sharing stories. Most often, sharers did not want to log out/in of accounts when someone temporarily used their device because it was inconvenient, which enabled *accidental* account sharing. This affected all sharing types except *mutual use*, which was not characterized by temporary use (though even in cases of *mutual use*, sharers sometimes forgot to log out; see the "spying" story above). Also related to adoption of security features, sharers commonly described not using lock screen PINs/patterns (in about one-quarter of sharing stories), in part to enable more convenient sharing. P11 lends her phone to her boyfriend and has no security lock because, "*It's easier for us to check something really quick.*" For those who did have PINs or passwords on their devices or accounts, they usually told them to frequent sharees, in part because this enabled easier sharing (see the "friends sharing PINs" example in *borrowing*). As noted above, six households had common passwords known by all family members to make it easier to access *mutually*

used accounts. For over a third of sharing stories, participants described providing their credentials to sharees.

The pervasiveness of convenience as a motivator for *how* and *why* people shared their devices and accounts is critical to how designers approach the creation of technology. We discuss implications of this and our other findings next.

DISCUSSION

Overall, our study contributes to understanding everyday device and account sharing practices. Here, we discuss implications for (1) research methods, and (2) designing technologies that are likely impacted by sharing.

Implications for Research Methods

Importantly, our study shows that what participants thought of as "personal" devices or accounts are not exclusively personal in practice. After the diary study, participants expressed surprise at how often they shared their "personal" mobile phones. The *invisibility* of certain types of sharing is important to call out. *Borrowing* and *helping* sharing types tended to be *unplanned*, which may have contributed to their invisibility. People may forget the situations when their spouse quickly looks up something on their phone or answers a call on their behalf; they may not see all the times their kids borrow their tablet to watch a video. Our results highlight that the language used to describe devices and accounts can be deceiving: "personal" devices are often shared; and sharing occurs in multiple ways and for a variety of reasons beyond the most obvious or visible.

This invisibility of sharing and potential ambiguity around the language has implications for research methods. Questions about sharing must be carefully worded. The terms "sharing" and "personal" are fraught with issues, potentially being overloaded or interpreted differently by different people. Even with clearly worded questions that we piloted and which specified sharing as "use of a device by more than one person," participants did not understand or recall the extent of their sharing until they completed the diary study. Our results show that certain types of sharing may be more or less top-of-mind. Thus in future research, it will be important to mitigate these risks, for example by including in situ or complementary methods, or providing examples of different types of sharing to help participants consider the range of relevant behaviors.

Implications for Technology Design

The major contribution of this paper for designers is the taxonomy of sharing types, which provides a framework for thinking about a variety of common sharing practices. Designers can use the taxonomy to evaluate how different sharing types would impact the use of new technologies being designed. To illustrate this, we present an example of how our taxonomy can be used by designers of *entertainment* accounts (e.g., music, video, or game accounts).

Designers of entertainment accounts can expect *mutual use* to be a very common sharing type among household members, according to our results. *Mutual use* was motivated by convenient access to shared content (e.g., a music or video library) and avoidance of extra subscription or content purchases. Thus, designers should consider group accounts that enable multiple users to sign up together and organize a shared library of content. Because all mutual users may frequently use the account, any personalization system employed (e.g., to make video recommendations) must consider sharing to avoid developing incorrect models that could result in poor personalization, consistent with prior work on Tivo viewer profiles [15]. To account for sharing, such personalization systems might try to detect who is currently using the account. *Mutual use* was common with one's significant other and children in our study. Systems may be able to leverage this knowledge by, for example, modeling differences between adult and child behavior to separate user activities. Finally, since creating and switching profiles was an issue with mutual users, improving profile interfaces is an important area for future design, though prior work has noted the challenges in doing so [5,8,11].

Borrowing and *broadcasting* were also common on entertainment accounts. Designers would help users avoid *accidental* sharing in these cases by creating easy-to-use guest modes. Within those guest modes, designers could consider suppressing notifications or auto-completes in text entry boxes. Many notifications pop-up previews of incoming messages, emails, calendar entries, and so on, which can reveal personal information to a sharee. Likewise, auto-completes in text entry boxes, which can improve usability, may unintentionally reveal previous web browsing, personal information entered into forms, and so on.

Setup is also an issue for shared entertainment accounts: one person likely initializes the account, meaning that all the other sharers may never see notice and consent material or know how privacy-related settings were configured. Designers of entertainment accounts should consider using approaches like "privacy check-ups" [2,35] to ensure all account users understand and agree to the privacy settings.

CONCLUSION

We have presented results from a multiple-methods study of common device and account sharing practices among household members and their relations. Among our key findings were that device and account sharing is common, and that mobile phones were often shared. The major contribution of this work is the organization of technology sharing practices into a taxonomy of six sharing types—distinct patterns of what, why, and how people shared. We also presented two themes that cut across sharing types: that (1) trust in sharees and (2) convenience highly influenced sharing behaviors and security-related decisions. Future work could explore device and account sharing among a different type of social group than household members (e.g., teens, friend groups, coworkers, and so on), in special situations (e.g., when traveling or during disaster response), or deeply within a single sharing type (e.g., *accidental*) using observation or other qualitative methods.

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