My Mom was Getting this Popup: Understanding Motivations and Processes in Helping Older Relatives with Mobile Security and Privacy

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Security and privacy pose a serious barrier to the use of mobile technology by older adults. While support from family and friends is known to be an effective enabler in older adults' technology adoption, we know very little about the family members' motivations for providing help, the context, and the process in which they provide it. To bridge this gap, we have conducted a mixed method study, qualitatively analyzing the helpers' assistance stories and quantitatively estimating the factors that affect helpers' willingness to offer assistance to older relatives regarding mobile security and privacy problems. Our findings point to the potential for helping older relatives, i.e., people are more willing to help and guide them than other social groups. Furthermore, we show that familiarity with an older relative's preferences is essential in providing meaningful support. We discuss our findings in the context of developing a theory of collective efficacy for security and privacy and new collaborative technologies that can reduce the barriers to social help.

CCS Concepts: • **Human-centered computing → User studies; Mobile devices.** • **Security and privacy → Social aspects of security and privacy**

Additional Key Words and Phrases: Older adults, Security and privacy, Mobile computing, Smartphones, Assistance, Support, Help

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1 INTRODUCTION

The world's population is aging. In the USA, 15% of the population is over 65, and the number of older adults is projected to reach 22% in 2050 [61]. Given this fact, it is increasingly important to help the aging population cope with a complex technological world. Older adults, who are classified in the literature as people over 55 years [45], are far from being a homogenous group that conforms to the myth of being technology adverse [44]. For example, 42% of American adults aged 65 and older reported owning smartphones at 2017 [3]. However, several studies show that older adults experience more difficulties in controlling their technological environment in mobile computing [48] and in mobile health applications [50]. Ensuring access to mobile technologies for all ages is becoming highly imperative as societies rely on these technologies for social life, work, health, education, and almost any aspect of contemporary living.

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Several studies have shown that security and privacy concerns are significant barriers to technology adoption by older adults [29,44]. Older adults find security and privacy as equally important to younger people [33]. However, they are more vulnerable to cyber attacks, especially on mobile platforms, such as phone-based fraud [67]. Older adults seek information about security and privacy differently [21,54,55], relying mainly on family and friends for support [47,54]. Older adults tend to emphasize their need for strong protection of personal information [15]. They have difficulties managing their security and privacy mechanisms and settings [66]. Without urgently addressing security and privacy challenges, older adults' access to vital technology is seriously limited and can even increase their anxiety in technology use [65]. In addition, as the strength of cybersecurity systems relies on its weakest link, having a vulnerable population that is exposed to cyber-attacks threatens all those who rely on the system.

Several studies and products are based on designing interfaces specifically for older adults, such as a mobile game applications [9] and social networking [27,51]. However, specialized interfaces have several drawbacks: they require additional investment which may or may not be available. More importantly, as they require to adapt existing technologies, they will not inherently include the most up-to-date technologies and applications. Similar challenges are involved in training older adults in the use of technology, as suggested by several studies [29,44,65]. Training would almost always lag behind the development of new technologies. However, older adults prefer face-to-face support, such as being advised and guided by friends and family, in the process of overcoming technological challenges [19]. Generally, users learn about security and privacy mainly from friends and family, and this phenomenon is significantly stronger in older adults than in young people [47,54]. Therefore, we also need to focus on understanding and enhancing existing support networks, using social learning and support to help older relatives overcome security and privacy problems. Ubiquitous and mobile computing research shows the potential in relying on communities for coproduction activities [12], to mediate transactions between service providers and customers [23], and to aid visually impaired users [2]. To design social support processes, we aim to examine the several questions that rely to the experience of the people providing help and to older adults: What are the characteristics of help processes for older relatives? How do these processes differ from helping other social groups? What factors are related to the willingness to help older relatives?

In this work, we examined helpers existing mobile security and privacy assistance process stories related to older relatives. We crowdsourced assistance stories from the helpers and analyzed the contexts and processes. We explored what factors that may influence people to provide help to older relatives, such as familiarity with preferences, and exposure approval and concerns. We also compared people's frequency and attitude towards assisting between older relatives and other social groups.

2 BACKGROUND

The background to this work connects three theoretical fields, namely, the age-based digital divide, usable security and privacy, and social help. We conclude this section by presenting our research goals and hypotheses.

2.1 Older Adults and the Digital Divide

Older adults many times fall on the wrong side of the digital divide. The digital divide is a distinction made between technology adopters, i.e., those who adopt and those who do not [44]. Nevertheless, some older adults use new computing technologies; 42% older adults own a smartphone, 67% older adults use the internet, 34% older adults use social networking sites such as Facebook or Twitter [3]. They face unique barriers to adoption, such as low confidence in their ability to learn about and properly use digital devices, and the need for others to show them how to use the new devices; despite these challenges, roughly three-quarters of internet users ages 65 and older say they go online daily [3]. Similarly, older adults' mobile technology use is characterized by several significant challenges, including technological complexity that challenges cognitive abilities, age-related capability changes, and a lack of learning and support mechanisms. These challenges associated with the sustainable use of computers can lead to disengagement [19] and anxiety [65]. Older adults prefer three different

styles for learning technology, namely, trial and error, step-by-step instruction manuals, and in-person instruction [8].

The important factors that influence older adults' adoption of technology are age, education, race, fluid and crystallized intelligence, cognitive abilities, computer self-efficacy, and computer anxiety [18]. Previous studies have suggested training older adults to improve their computer self-efficacy and interest and to decrease computer anxiety, in order to increase their use of technology [44,65].

Older adults are more likely to adopt new technologies after observing that they have been successfully adopted and used by other social connections and when they see clear benefits for themselves [64]. For example, Barnard et al. [8] reported that older adults try out the computer of their grandchildren and observe how friends and family use the technology before buying one. Younger people often learn new technologies at school or work, but for many older adults, this is often not the case. Often, older adults fear breaking things and need someone close to help them if something goes wrong [8]. Studies have shown that older adults prefer face-to-face support rather than seeking help from other sources, including the internet, online forums, or online social networks [8,19,52]. Simply put, friends represent low time and financial costs and a longer-term help relationship. Often, a close social connection understands the technical competence and environment of the seeker and can calibrate solutions accordingly [52]. Personal support by familiar people such as family and friends should therefore be available to older adults.

Existing solutions to help technology adoption by older adults is mostly focused on self-efficacy, defined as the belief of a person in his or her innate ability to perform a particular behavior in a variety of circumstances [4,5]. However, we see growing evidence for the importance of collective efficacy in many domains. Collective efficacy is defined as the group's shared perception of its capability to successfully perform some behavior [6]. People's shared beliefs in their collective power to produce desired results are a key factor in collective agency [7]. Collective efficacy is important for reducing violence in neighborhoods [59], finding outstanding schools [22], maintaining an exercise program for diabetes patients [10], and for adult education [16]. Available assistance may increase collective efficacy and increase the ability of older adult to successfully perform security and privacy behaviors.

2.2 Older Adults' Interaction with Security and Privacy

Security concerns deter older adults from using digital devices and information technology services [13,29,44]. Both younger and older adults perceive privacy as equally important, but from different reasons; older adults are prone to phone and SMS fraud, whereas younger adults are exposed in social network services [68]. Privacy concerns and the fear of being exposed to inappropriate content are the main barriers to social network adoption by older adults [45]. Their concerns include protecting other group members, especially family members [41]. Security issues are often mentioned when discussing the reasons for disliking technology by older adults [44]. They fear the potential risks of information intrusion through sensor or computer monitoring, and the potential that the information could be given to the wrong people [11]. Therefore, to ensure that older adults can confidently access digital technologies, security and privacy barriers should be overcome.

Older adults tend to rely on digital security advice from family and friends significantly more than younger people [54,55]. Studies have shown that social ties, more than other sources, influence the users' susceptibility (for all age groups) to adopt security and privacy behaviors [43] and that social cues can make users more likely to adopt the same security behaviors as their friends [20]. Furthermore, older adults may have concerns about sharing their personal information with strangers, which is often the case with security and privacy support [37]. For example, if the help is provided by a collaborative technology, such as CollaDroid [67], the helpers are able to see the application screens of the seeker.

2.3 Social Support

Social support is the process of receiving free assistance from other people (rather than receiving paid support). Social support processes have two main players, namely, helpers, who are the people who provide technical

help, and seekers, who are the people who receive outside technical assistance. Social support can take the following three main forms: through large online help communities (e.g., "Stack Overflow"), through crowdsourcing markets, or by receiving direct support from the social network.

Several studies have suggested crowdsourcing help for information access requests [38], seeking minimal sets of permissions that will preserve the usability of the app for diverse users [34], answering location access requests [60], and finding expert users to give permissions to inexperienced users [53]. When novice consumers were exposed to crowdsourcing explanations, their objective knowledge increased, but their subjective knowledge decreased [32]. Nevertheless, social network resources are essential for answering certain queries [25], for the delivery of personalized answers, and for increased confidence in the validity of the search results [46]. Older relatives therefore choose social support over formal processes that supply professional services from the technology supplier, because of limited accessibility due to cost, convenience, comfort, and trust [52].

Taking advantage of peers for technological support and learning has been investigated in the context of the workplace. There is rich research literature describing work-related peer learning and support [24]. For example, systems for finding support for work-related issues [56] and for finding peer helpers [31,40]. In the workplace, weak-tie connections may offer useful advice and solve technical problems thanks to a diversity of skills [17], but in most cases workers seek help from accessible, trusted, and expert colleagues [57]. However, in non-workplace environments, helpers tend to provide lower quality of help to people they do not know well [52]. These contradictory findings raise the question of what the optimal way is to support older adults in nonwork scenarios, i.e., whether familiarity and close connections play an important role in providing help.

2.4 Research Objectives

Our long-term goal is to improve older adults' security and privacy by understanding the process of helping older relatives with mobile security and privacy challenges. First, we want to characterize the assistance process. We wish to gather basic statistics about the helpers' experiences to provide assistance to older relatives: how often these events occur. Second, we ask what are the factors that influence helpers' willingness to provide help. We examine the following factors: relationship, help problem type, frequency and attitude to assist, altruism, helper familiarity with seeker preferences, exposure approval and concerns, and time to solve the problem.

We hypothesize that helpers report that older relatives request in-depth assistance more than other people (Hypothesis 1) and receive in-depth assistance more than other people (Hypothesis 2), on the grounds that people provide a higher quality of help to those they know well [52]. Knowing the preferences influences the willingness to help older relatives (Hypothesis 3). Finally, the frequency and willingness to assist older relatives is higher than for other people (Hypothesis 4), on the grounds that older adults learn about security and privacy mainly from friends and family [54].

3 METHODOLOGY

3.1 Questionnaire

To test our hypotheses, a user study was conducted based on a questionnaire (see Appendix A). In the first part of the questionnaire, the participants were asked to recall an experience of a smartphone security or privacy problem where they provided assistance in the last 12 months and to describe the issue and what they did to solve it. These two open-ended questions were analyzed using the grounded theory approach. We explain the coding process in section 3.3. The study received the ethics approval from the Institutional Review Committee (IRB).

In the second part of the questionnaire, we asked close-ended questions regarding the other measures. The *seeker expectation* is defined as the type of assistance that the helper understands is needed from the seeker (e.g., what did they ask you to do?). The seeker expectation reflects the modes of assistance the helpers believe the seeker has asked for. This question contains four options for assistance mode that are described in Table 1; the

Table 1. The assistance modes

Category	Description
Advise	Offering an opinion, suggestion, recommendation or information as a worth following of how to solve the security and privacy problem
Guide	Assisting in the form of displayed instructions on how to solve the security and privacy problem
Demonstrate	Fixing the problem while presenting on the screen for viewing how to solve the security and privacy problem
Fix	A measure is taken to resolve a security and privacy problem without involving the help seeker

participants had to select one option that best represented their described experience. The options were developed in a separate pilot study, in which participants were asked to recall an experience of a smartphone security and privacy problem where they provided assistance in the last 12 months. One researcher developed the codebook and another researcher separately coded the data. We conducted a Cohen's Kappa test for the seeker expectation code (Kappa = 0.756, Raters = 2, Subjects = 108, z=10.9).

The *help medium* is the technique that the helpers used to provide assistance: face-to-face, phone, email, video call, or messaging. We have also asked the participants about the assisted person: the *relationship*, *seeker age*, and the *repeated help frequency* with the same type of a problem. The *group relationship* variable was calculated according to relationship and age. If the relationship was with a parent or a grandparent, and the age was above 54, the group relationship was set to "older relatives." If the relationship was with acquaintances, colleagues, and others (e.g., spouse, niece, sibling, aunt, and uncle), then the group relationship was set to "others."

We had six single questions referring to the described smartphone security or privacy problem experience, that were answered with a 5-point agreement Likert scale (see appendix 1). *Technological emergency* represents the extent to which participants feel the problem is important for the seeker. *Time to solve the problem* represents the extent to which participants think solving the problem took them a long length of time. *Willingness to assist* represents the extent to which participants are happy to assist the person again in solving another technological problem. *Familiarity with preferences* measures the extent to which the participants' knowledge of the seekers' preferences helped them solve the problem. *Seeker exposure concerns* measures the participants' concern with being exposed to sensitive personal information while providing help. *Exposure approval* represents the degree to which the participants think that the seeker is okay with the information they have seen while solving the problem. The two exposure variables reflect the privacy concerns that helpers can have while interacting with the seeker's phone.

In the last part of the questionnaire we have four variables. First, the *frequency to assist* variable represents the frequency with which participants assisted other people with security and privacy problems on a smartphone in the last 12 months, by asking similar questions, but referring to the various social groups: close friends, acquaintances, colleagues, parents, and grandparents. Second, the *willingness to assist frequently* variable represents the frequency which participants were willing to assist other people with security and privacy problems on a smartphone, by asking similar questions, but referring to the various social groups. Third, *attitude to assist* represents the degree to which participants had an attitude to help other people with security and

privacy operation problems on a smartphone per social group. Forth, *altruism* represents the extent to which a participant has carried out altruistic behaviors in the past and is adjusted based on the measurement developed by Rushton et al. [58]. Finally, we collected demographic data on the participants.

3.2 Participants

We recruited participants via Amazon Mechanical Turk (MTurk), which is commonly used in privacy (e.g., [30,62,63]) and security research (e.g., [26]). The MTurk workers are relatively more technically proficient than the general population [39] and thereby are more likely to help their relatives. The participants were required to be at least 18 years old and located in the USA, as we wanted stories that are written in English. They were payed $1 per task, and the average completion time was 2.3 minutes (the average hourly payment rate was $26). To avoid priming, the study's objective and title were about helping other people and asking for help in operating a smartphone. The user study included 250 participants, and after the cleaning process, 198 participants remained (they received a $0.5 bonus). We cleaned the data by examining the open questions and removing participants that have left no answers or very short answers. The gender distribution included a total of 85 females and 112 males; for the age groups of 18-24, 25-34, 35-44, and 45 and older, the distribution was 9, 102, 56, and 31, respectively. The older relatives' group consisted of 86 examples (only parents or grandparents aged over 55, which classified in several works [45]) and the other social groups included 101 examples (43 close friends, 19 colleagues, 5 acquaintances, and 34 other), hence we remained with 187 stories (see Table 2 for a summary of participants' demographics and the people they assist). Our analyses were carried out separately to older relatives and other social groups.

Table 2. Distribution of participants (helpers) age, gender, relationship to the seeker, and age of the seeker

			Seeker			
	Gender	**Relationship**	Older relatives	Other social groups		
		Age	Above 54	Under 35	35-54	Above 54
Helper	Female	Under 35	20	9	7	2
		35-54	18	8	9	4
		Above 54	2	-	-	4
	Male	Under 35	30	24	3	6
		35-54	16	3	12	6
		Above 54	-	2	-	2
Total			**86**	**46**	**31**	**24**

3.3 Data Coding

The open questions were analyzed using the grounded theory approach. We had two goals in mind throughout the coding process. The first goal was to understand the type of assistance that the helper provided, and this was coded as *helper reaction.* It was extracted from the open questions according to the rules of the pilot that established categories and keywords. One researcher developed the codebook and another researcher separately coded the data. Then, we performed Cohen's Kappa test on the helper reaction code (Kappa = 0.8, Raters = 2, Subjects = 108, z=12.1). The categories of the helper reaction were similar to the categories of the seeker request (the close-ended questions). The second goal was to better understand the *triggers*, which are events that cause

the seeker to ask for help and to start the assistance process. The Cohen's kappa test was performed on the trigger variable in the first 91 examples of the current dataset by a second researcher (Kappa = 0.815, Raters = 2, Subjects = 91, z=18.1). The Cronbach's Alpha for the frequency to assist others, attitude to assist others, and altruism are: 0.75, 0.68, and 0.69; Respectively. We use these variables in section 4.4. We also coded the helper's technical aptitudes based on the participants' description of assistance story (see Section 4.1.). We measured interrater reliability using Cohen's Kappa test on the technical aptitudes code (Kappa = 0.715, Raters = 2, Subjects = 187, z=13.8). The Kappa score for technical aptitudes represents fair to good agreement beyond chance[28].

4 RESULTS

The participants indicated the relationship and age of the person that they assist with mobile security and privacy problems. Their answers differentiate between assistance to older relatives and assistance to other social contacts. When 86 of the answers described assisting an older relative and 101 of the answers described helping other social contacts on mobile security and privacy problems. In this section, we define the assistance process on mobile security and privacy problems for older relatives, and then we compare it to other social groups. We investigated the factors that influence the willingness to assist older relatives with mobile security and privacy problems. Finally, we investigated the attitude and willingness to assist different social groups on mobile security and privacy problems. This was analyzed regardless of the participants' sorties and to whom they assist.

4.1 Assistance Process of Older Relatives

We describe the assistance process in three parts: the triggers to the process, the seeker expectation, and the helper reaction (see Fig. 1). The triggers and helper reactions were coded from the participants' assistance with mobile and privacy stories. The seeker expectation is the participant perceived assistance type, while the helper reaction represents the actual assistance type that was provided based on the assistance story. The assistance process analysis of older relatives is described in the following three sub-sections. To characterize the help processes for older relatives, we defined the triggers and helper reactions that were coded from the open questions, then compare the seeker expectation and helper reaction.

The Trigger. We defined *trigger* as an event that starts the help process. It was coded based on the participants' experience in assisting smartphones privacy and security problems. The trigger was coded for each story to one of the following seven categories: privacy concerns, interruption management (e.g., notifications and pop-ups), permissions management, security management (e.g., malware, spam, updates, etc.), password management, new phones, and operating an application (e.g., using, install, or delete an app). The categories and the number of older relatives is displayed in Table 3.

Privacy concerns. This category represents the seekers' concerns about applications or systems that collect the data. For example, when the helper was requested to deny the permission: *"The issue was that my mother in law gave all of her apps full permissions without realizing it."* (P118). In some cases, the privacy concerns originate from the media, new applications, suspicious smartphone behaviors, or privacy needs. For example, when privacy concerns of older relatives cause by the media: "*My mom heard something on the news about apps being able to see your phone number and sell it"* (P11). Older relatives can use a new smartphone: "*My mom is new to smartphones and is very suspicious of them, so she did not want any tracking going on.*" (P62). They can notice suspicious smartphone behaviors: "*I got a call from my grandfather who was concerned that he had his information stolen due to his smartphone use. He thought it might be tied to an app that he used.*" (P217). They can have privacy needs: "*My mother needed assistance in disabling Facebook's location tracking on her phone.*" (P13)

Interruption management. This category occurs when the seeker receives a message, notification, or pop-up, e.g., Adware usually adds advertisements and popups on the mobile. For example: *"My dad was bothered by unnecessary notifications from apps on his phone..."* (P77).

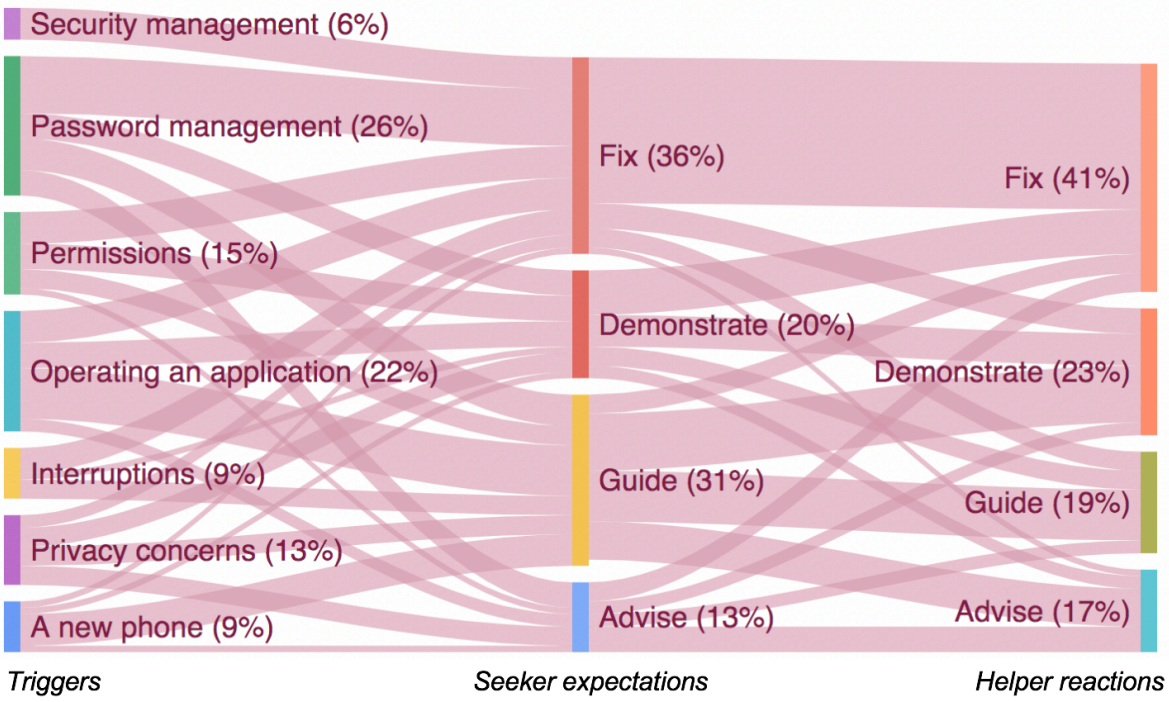

Fig. 1. Assistance process of older relatives: triggers, expectations, and reactions

Permissions management. The permissions management category is related to grant permissions in order to use the applications: "*The issue was that the person was unable to use the maps app on their phone, because they didn't realize they had to have location services turn on in their privacy settings.*" (P3). We noticed that for the privacy concerns category, participants were asked to "deny" permissions and for the permissions management category they were asked to "grant" permissions.

Security management. This category represents the protection from malicious 3rd party entities, which are not the data collector. It is a collection of addressing threats that include malware, viruses, and security updates. All of these cause by applications or malware that influence the seeker smartphone badly. For example: *"My mom needed a virus removed from her phone, so I installed MacAfee"* (P102).

Passwords management. This category is related to manage, remembering and setup passwords or login difficulties. For example: "*My mother tends to forget which password she uses for her various devices (phone, tablet, laptop) and it creates problems. Last time I saw her she was not able to update the OS on her phone because she could not remember her password.*" (P85). To solve the password remembering problem, few participants offer to setup fingerprint scanner: *"I set up fingerprint scanner on her (parent) phone so she can access the apps without entering the password."* (P177), *"Installing a password manager."* (P194) or canceling the password: *"My grandma needed help getting rid of her passcode. She didn't want it anymore."* (P103).

Installing a new phone. When the older relative receives a new smartphone can ask for assistance: "*My mother got a new phone and was porting over all of the apps she needs, and I noticed they were all asking for blank permissions.*" (P2). When older relatives required to use a new technology or learn to operate a new function that is totally unfamiliar to them, they would turn to their children or grandchildren for help rather than refer to other sources.

Table 3. Categories and examples of help story trigger

Triggers	# older relatives	Examples
Privacy concerns	11 (13%)	*"My mother had heard about recent data breaches and got quite scared, wanting to make sure she would be safe from this on her phone." (P39)* *They (parents) thought some of the things they were asking were too personal. (P109)*
Interruption management	8 (9%)	*"I had to help my mother delete an app that was on her phone that was giving pop up ads every time she went on her google app." (P243).* *"My mom was getting constant text messages from a phone number that she didn't know, and she wanted me to help her fix that problem." (P52)*
Permission management	13 (15%)	*"My mom called a few months ago and said she was getting a pop-up on her phone from Facebook asking for permission to access her photos. I asked her if she was trying to upload photos and she said yes so I told her to allow it." (P87)* *"My mom needed help figuring out why her favorite game app wouldn't open. It was linked to Google somehow and needed some kind of permission to access the app that wasn't happening somehow." (P94)*
Security management	5 (6%)	*"I helped my grandma install her security updates." (P171)* *"My mom needed a virus removed from her phone so I installed MacAfee (P102)*
Password management	22 (26%)	*"I helped my mom set a password for her phone." (P50)* *"My dad just installed Uber to work on it and I helped set up the fingerprint authentication and help him recall his password in a safe way" (P128)*
Installing a new phone	8 (9%)	*"This was about a week ago my grandma got a new iPhone. She was used to her old android and did not know how to set up a passcode for the phone." (P8)* *"I helped my mom with her new phone. she needed help transferring everything from her old phone to the new one and connecting it to her iPad." (P250)*
Operating an application	19 (22%)	*"My mother needed to install PayPal, but she is very technologically illiterate, so she needed help with the installation and setup of the app." (P187)* *"I helped to install the app, and that allowed them to then enter their credentials and log in. I showed them how to use the app and what it would be useful for. I double checked to make sure the app was the right one and not malware." (P213)*

Operating an application. This category is with the highest observations. The participants consider this category as a privacy and security help process: "*I helped someone remove a messenger app that was interfering with their Facebook messenger. Her messages could not be sent without getting messages from the other app."* (P181).

The Helper Reaction. We defined the *helper reaction* as the actual type of assistance that the helper gave the seeker in solving their smartphone security and privacy problems. It was coded based on the participants' experience and represented the actual type of assistance that the helper gave the seeker. We coded each helper reaction story by the following categories: advise, guide, demonstrate and fix. The categories descriptions are displayed in Table 1, see the categories and several examples in Table 4. The seeker expectation is the perceived type of assistance that the helper understood the seeker to require. The seeker expectation and helper reaction have the same categories.

Guide. Participants guide older relatives to make sure that they will know how to solve the problem in the future by themselves: *"My grandmother recently purchased a newer smartphone … I verbally walked her through the steps with one download, then watched her do the next on her own so she would be able to get all others she desired with or without anyone's help."* (P231). In other instances, helpers guide the seekers by writing the instructions: *"My mom was getting all kinds of notifications from her apps… I showed her how to get into her settings and turn off all notifications from the apps she wanted off. I wrote down instructions on how to do it too for future reference."* (P20)

Table 4. The seeker expectation and reaction categories for older relatives and other social groups

Relationship	Older adults		Other social groups		Example of assisting older relatives
Category	#Expectation	#Reaction	#Expectation	#Reaction	
Advise	11 (12%)	13 (17%)	21 (21%)	18 (18%)	*"An older relative asked for help with her passwords because she kept forgetting hers. I used some tips I picked up at work to help her come up with memorable ones." (P236)*
Guide	27 (31%)	18 (19%)	21 (21%)	5 (5%)	*"My mother could not login to her iPhone using her apple id. I instructed her on how to go to apple and reset her apple id password. Afterwards she was able to login using the new password." (P98)*
Demonstrate	17 (20%)	20 (23%)	21 (21%)	24 (24%)	*"My mother needed assistance in disabling Facebook's location tracking on her phone. I showed her how to change the permissions so she could fix similar issues in the future by herself." (P16)*
Fix	31 (36%)	35 (41%)	38 (37%)	54 (53%)	*"My mom keeps forgetting her passwords. I set up fingerprint scanner on her phone so she can access the apps without entering the password." (P177)*

Fix. Most participants fix the problem for their older relatives. The older relatives know what they want but do not know how to solve the problem: *"I helped my mom get rid of Google news notifications that she was receiving on an hourly basis. I went into the phone's settings and disabled all notifications from Google apps."* (P47).

Advise. Participants provide advice to their older relative, suggesting ways to solve the problem. For example: "I *told them (parents) to write down all of their passwords for their apps in their notes on their phone. I also told them to make a password on their phone so that only they can access their phone."* (P30). In this example, the helper assumes that the seekers have prior knowledge about using a notes application. Participants can give information and teach their older relatives: "*I taught them how to create strong passwords, and explained why it is important to use different passwords for each app. I also gave them tips on how to remember the different passwords.*" (P88)

Demonstrate. This category refers, in most cases, to an operation that older relatives do for the first time: "*My mother got a new smartphone. She wanted to insure it was secure but wasn't sure how. I showed her how to create a password to open the phone and also how to record her fingerprint to open the phone*" (P40). Sometimes the older relatives only needed a short hint to start the operation: "*My mom did not understand how not to allow an app to keep sending her notifications constantly. I showed her where in the settings you could turn off notifications."* (P141)

Comparing Older Relatives Expectations and Helper Reactions. We first examined how older relatives and helpers negotiated the type of assistance. In our sample of 86 stories assisting older relatives with mobile security and privacy, a chi-squared showed that there is a significant association between the older relatives expectation and helper reactions ($\chi 2=28.784$; df=9; p-value<0.001), namely older relatives are more likely to receive the same type of assistance that the helpers think they requested. When examining all possible combinations of the older relatives' expectations and helper reactions (using Bonferroni correction [14]), it was seen that older relatives with fix expectation and fix helper reaction are coded significantly more than expected while older relatives with guide expectation and fix helper reaction are coded significantly less than expected

(see Fig. 1). Hence, the type of assistance provided on mobile privacy and security depends on the older relative expectation. For instance, when both the helper reaction and the perceived expectation were "fix" (22/86):

> *"My mom was getting constant text messages from a phone number that she didn't know, and she wanted me to help her fix that problem. What I did was go into the privacy section of the phone app and blocked that specific number, so she didn't receive text messages anymore."* (P53)

Another example where both the helper reaction and the older relative expectation were "guide" (8/86):

> "*My grandmother recently purchased a newer smart phone and was unsure how to download or install any apps. It was not that she wanted to play so much but she also needed some of her more important things to access such as her bank and prescription apps. I verbally walked her through the steps with one download, then watched her do the next on her own so she would be able to get all others she desired with or without anyone's help."* (P231)

Help Medium. The most popular technique the helpers used to provide assistance was through face-to-face interaction. In 166 of the 187 of participant stories, help was provided through face-to-face, 21 of 187 reported using phone, messaging application or in other form.

Technical Aptitude. We have categorized the stories according to their technical complexity involved in them. We categorized participants' stories to three levels of technical aptitude, with 86, 44, and 57 for high, middle, and low technical aptitudes, respectively. The three categories of technical aptitude for stories related to older relatives are 41, 22, and 23 for high, middle, and low, respectively. High technical aptitude describes scenarios in which the scope of the story is related to using the settings of several applications or features and requires a deep understanding on behalf of the helper. For example, "I showed her (mother) how to create her apple ID. I showed her how to create passwords for everything and explained to her the safety of having a good strong password..." (P113). Medium technical aptitude shows a fair understanding and the scope of the described story related to a specific application or feature. For example, "I set up the fingerprint confirmation to make it clearer for him to use and so that it worked as his password" (P187). Finally, the low technical aptitude shows basic understanding and a limited number of activities: "I walked him (father) through resetting his password. We then wrote down the new password." (P81)

4.2 Comparing Older Relatives and Other Social Groups

The older relatives' expectation and the other social groups expectation have the same type of assistance (Pearson's Chi-square test: $\chi 2= 3.8276$; df = 3; p-value= 0.2807). When examining all possible combinations of older relatives and other social groups expectations (using Bonferroni correction), it was not seen any differences between them. Hypothesis 1 was therefore not supported. Similarly, we did not notice significantly different triggers between the older relative and other social groups (Pearson's Chi-square test: $\chi 2= 2.883$; df = 6; p-value= 0.8234). However, the helper reaction is significantly different between the older relative and other social groups, supporting Hypothesis 2 (Pearson's Chi-square test: $\chi 2= 10.178$; df = 3; p-value= 0.017). When examining all possible combinations of helper reaction with older relatives and other social groups (using Bonferroni correction). Guiding is more expected for older relatives (17/86) than to other social groups (5/101); i.e., the only difference in helper reactions between older relatives and other social groups occurs in guiding (see Table 4).

4.3 Helper Demographics

We analyzed the connections between the demographic properties of the helper (gender, age, and technical aptitudes) and type of help (the seeker expectation and the helper reaction). These demographic categories did not exhibit a statistically significant difference in the values of the seeker expectation and the helper reaction.

In addition, we examined all possible combinations of helper reaction with age and technical aptitudes (using Bonferroni correction) and we found no statistically significant differences between the combinations. Similarly, we did not find a statistically significant difference according to the relationship of the participant with the seeker (older relatives and other social groups) and the relation to age and technical aptitudes.

4.4 Willingness to Assist

The participants' willingness to assist older relatives represents the positive emotion to further assist in solving another technological problem. A linear regression model was created to predict the willingness to assist older relatives (see Table 5). The older relatives model significantly accounted for 35% of the variance in willingness to assist (Adjusted R^2 =0.35; F (8,77) = 6.825; p<0.001). The familiarity with preferences (β=0.29, p-value<0.001) has positive effect on the willingness to assist older adults. This finding supported Hypothesis 3. Exposure approval (β=0.26, p-value<0.05) has a positive effect on the willingness to assist older relatives, and time to solve the problem has a negative effect on the willingness to assist older relatives (β=-0.33, p-value<0.001). The technological emergency, seeker exposure concerns, and altruism do not have a significant effect the willingness to assist. The linear regression was also tested with age and gender of the helper and the model was similar with those controls.

4.5 Assisting to Different Social Groups

In this sub-section, we analyzed the frequency with which the participants assisted other people with smartphone security and privacy problems for close friends, acquaintances, colleagues, parents, and grandparents. In our sample of 187 participants (regardless whom participants reported to assist), the frequency of assistance shows a statistically significant difference among the social groups (Friedman rank sum test: χ2=324.57; df=8; p-value<0.001). Participants helped parents more often than any other social group: close friends (Wilcoxon signed test: V=1163.5; p-value=0.001), acquaintances (V=3644; p-value<0.001), colleagues (V=3393.5; p-value<0.001), and grandparents (V=4829; p-value<0.001). Participants helped close friends more

Table 5. Linear regression of the willingness to assist by factors for older relatives, displaying coefficients (and Std. Error). Significant p-value codes: . p<0.1; * p<0.05; **p<0.01; ***p<0.001.

Property	Coefficients
(Intercept)	1.94 (0.77)*
Technological emergency	0.08 (0.08)
Time to solve the problem	-0.33 (0.09)***
Familiarity with preferences	0.29 (0.08)***
Seeker exposure concerns	-0.08 (0.1)
Exposure approval	0.26 (0.13)*
Assisting frequency	0.08 (0.15)
Assisting attitude	0.08 (0.12)
Altruism	0.02 (0.03)
Adjusted R2	0.35

often than acquaintances (V=1371; p-value<0.001) and grandparents (V=3264; p-value<0.001), but not colleagues (V=1763; p-value = 0.056).

The willingness to assist frequently was analyzed by how often the participants were willing to assist other people with smartphone security and privacy problems in the last 12 months for close friends, acquaintances, colleagues, parents, grandparents. In our sample of 187 participants (regardless whom participants reported to assist), the frequency with which people are willing to assist others is different among the social groups (Friedman rank sum test: $\chi 2=244.47$; df=8, p-value<0.001). Participants were willing to provide help to parents more frequently than to any other social group, including close friends (Wilcoxon signed test: V=258.5; p-value=0.01), acquaintances (V=2102; p-value<0.001), colleagues (V=1487; p-value<0.001), and grandparents (V=1878.5; p-value<0.001). These findings supported Hypothesis 4.

We noticed a gap between the willingness and frequency of assistance for each social group (Wilcoxon signed test: p-value<0.001). A possible interpretation is that participants can help more than they currently help, especially their parents. The average and median score for parents is 4; that is, they are willing to assist with smartphone security and privacy problems once a week, when the current frequency of help is once a month.

5 DISCUSSION

The purpose of this study was to collect and analyze helpers' assistance stories with mobile security and privacy. We provide several theoretical implications and insights about the design of social support systems for mobile computing. First, we introduce the social support technology design implications. Second, we describe possible designs based on existing social networks. Finally, we discuss several limitations of our study.

5.1 Social Support for Older Adults

Supporting all assistance modes. Most importantly, our findings point to the potential of close social help in mobile security and privacy. People's willingness to assist was higher for older relatives than for any other group, making assistance from younger family members is a promising solution. There is a variety of assistance modes that were asked by seekers and were assisted by helpers, but existing support technologies mostly support only a single assistance mode. For instance, remote control technologies (such as TeamViewer and CollaDroid [67]) allow the helper to take control of the seeker's mobile phone. Therefore, the assistance mode in these kinds of technologies is related to the fix mode and other assistance modes are neglected. The findings show that helpers fixed the problem only in 41% of the cases; in the other cases, the help mode either giving advice, demonstrating, or guiding. Thereby, we argue that models for assistance processes should support most of the modes and not only the fix category. Similarly, works that focus on sharing behavioral patterns for older relatives [42], are only applicable for demonstration and advise, and not for the whole range of assistance interactions.

Teaching older adults about mobile security and privacy. Comparing the expectations of older adults and other age groups shows very similar patterns. The non-fix for older relatives is similar to other social groups (36% and 37% respectively). Older relatives seek to receive in-depth help in similar proportions to other social groups. These results support previous studies that reported that older adults' intention is to learn and explore the technology [8], at least as much as other social groups. Helpers provided older relatives more guidance compared to other social groups. These results are also compatible with the qualitative results presented by Poole et al. [52].

Clarify the older adults' expectation. The particular nature of helping older relatives is evident when comparing assistance to different social groups. Although the expectations of the older adults were similar to other groups, the helpers provided more guidance to older relatives compared to other social groups. Older adults generally learn about security and privacy from their family and close social groups [47,54]. We show that when helpers perceived that older relatives expect to be guided, the proportion of fixing mode goes down.

Managing older adults' sensitive information exposure. Privacy is playing a moderate role in assistance processes. When the helpers perceived that the older relatives are comfortable with the information they are

exposed to while assisting, then the willingness to provide assistance increases. These findings show that privacy concerns on the side of the helper may harm the assistance process. In the social support technology design, privacy settings management tools are important to hide and notify the older adults' sensitive information exposures.

Considering older adults' preferences. Familiarity with the seekers' preferences plays a significant role in help processes. Familiarity is highly correlated with the motivation to help. One possible explanation relates to the individual differences between users and the variety of preferences in mobile security, and especially privacy. For example, people can have different preferences for privacy settings (access to different resources) and security settings (PINs, passwords, biometric identification, and so forth), and effectively helping people can require a good understanding with those preferences and deep familiarity with the person. These findings demonstrate the importance of close social connection in assistance processes. Eliciting the preferences of users in a way that would be understood by crowdsourcers [53] can be too limited in tasks that requires some level of familiarly with the user. For example, when judging whether to allow an application access to the older relative's microphone, the helper may need some prior knowledge about the likelihood that the older relative will use the voice messages service which is the reason to approve microphone access. Familiarity with the cognitive abilities of the older adult may help in assisting in rememberable a manageable password.

To understand the potential of extending close social help to older relatives, we need to develop theory that can classify and explain different modes of assistance and their potentially positive effects. Assistance in the form of guidance, advise and demonstration has the potential of increasing older adults' self-efficacy in privacy and security [8]. However, in other fields such as education and criminology, scholars refer to collective efficacy as the collective power of a group of people to tackle and overcome problems [7]. Our findings show that analyzing mobile security and privacy should also take collective efficacy into account, as older adults can better face challenges close social group members fix some of the problems for them. To understand the potential of social help in this process, we would like to point people are willing to help older adults significantly more frequently than the frequency of assistance that they report. We explain this gap by the friction in providing this help, especially when people are not co-located. However, we also believe that it a clear potential for social support if the friction can be reduced.

5.2 Design Implications for Mobile Assistance

Remote support is an area of active mobile computing research. Two recent technologies for remote support include Suhrid, which provides a collaborative mobile phone interface for low literacy people [1], and CollaDroid, which provides Android applications with interactive collaboration [67]. However, based on our findings supporting older adults, the design of these types of interfaces should take several issues into account. Our study points to a relationship between support and learning. If the interfaces allow other people to perform the tasks, then the recipient might not learn through the process. We therefore suggest exploring collaborative designs that would facilitate learning and training, and implemented by our design and good alternative for the face-to-face interaction, the preferred medium for supporting older adults [8]. Although serval mobile security and privacy designs for older adults were suggested [42], for our knowledge, the literature did not investigate and design technology for the assistance process in aspect of the helpers.

Our findings can be used in the design of future mobile assistance systems for older adults:

- **Using existing social networks**: build on the user's existing social ties rather than crowdsourcing. Currently, people assist older relatives and friends in mobile security and privacy problems and are willing to help them even more. Helpers prefer to assist older relatives that they familiar with their preferences. Thereby, we argue that social help technologies can work if it allows older adults to contact helpers that are family and friends.
- **Supporting wide range of interactions**: fixes, guidance, demonstration, and advice. Creating assistance mechanisms that support the variety of modes of assistance modes allow the helper to better answer the seekers' needs.

- **Promote interaction that encourages learning**: striving to modes of help that promote learning and increasing the older adults' self-efficacy. We recommend that a social help technology that the interaction sets to fix assistance mode should be accompanied by learning assistance modes.
- **Solving the co-location problem**: many interaction stories rely on co-location and extensive explanations of the problem and the solution. As users are not co-located most times, allowing them to provide rich explanations in a remote way is crucial. Therefore, we argue that social help technology can work only if it allows for both problems and solutions to be explained even if the users are not co-located.
- **Privacy controls that support assistance processes**: Assistance processes cannot be carried out if seekers are uncomfortable with the information they share and if helpers are uncomfortable with the information they are exposed to. Social help technology design should include privacy mechanisms that protect older relative private information and allow to hide sensitive information.

5.3 Limitations

This research is limited in several ways. Similar to other studies (see [37,54]), our results are based on self-reported behaviors and on Amazon Mechanical Turk as the participant recruiting platform. However, studies have found that Amazon Mechanical Turk workers are more technically savvy and more privacy aware than the general USA population, which may be suitable for the population of helpers. They also represent a diverse population sample in terms of age, gender and education [35,36,49]. While we do not claim that the study samples the population, these characteristics give credibility and context to the stories we analyzed. We focus on seeker preferences, but also capabilities and limitations (e.g., memory, motor ability) may affect the willingness to provide assistance in mobile security and privacy problems and should be investigated in the future.

6. CONCLUSION

In this study, we investigated how people assist older relatives with mobile security and privacy problems. We found variety of triggers and types of assistance in mobile security and privacy assistance process. The type of assistance that is provided in mobile privacy and security depends on the type of assistance that the helper understands is requested. When the helper perceives that the older relatives expected guidance, then in-depth assistance provides to older relatives especially. Furthermore, we show that familiarity with an older relative's preferences is essential in providing meaningful support and protecting the older relative's information is important to the helper in providing assistance. Finally, we demonstrate the potential for social help: people are more willing to help older relative than they currently do today. Our findings in the context of mobile security and privacy show important design insight to develop collaborative technologies that can reduce the barriers to social help.

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A QUESTIONNAIRE

Each participant response to the following questions:
In the last 12 months, have you helped anyone to solve a smartphone problem? Check all the options that apply.

1. I have helped someone with managing app permissions (such as access to location, camera, microphone, and contacts)
   - I have helped someone to install an app I have helped someone to delete an app
   - I have helped someone to use an app
   - I have helped someone with creating or remembering passwords
   - I have helped someone in another way (give an example)
   - No

[*Coded variables: trigger and helper reaction*] Please recall an actual experience, which happened in the last 12 months, and in which you have assisted someone to solve a smartphone problem related to privacy and security (such as with app permissions, passwords, malware, and so forth)

2. Describe, in your own words, what was the issue that needed assistance?
3. Describe, in your own words, what did you do to assist?
4. [*variable: seeker expectation*] What did they ask you to do? Please select one answer that best represents the experience you described. [They asked me to fix the problem for them, They asked me to fix the problem and to show what I was doing, They asked me to guide them step-by-step in solving the problem, They asked me to advise them on how to solve the problem, They asked me to explain to them what caused the problem, Other]
5. 5. [*variable: helper medium*] In which way did you provide assistance? Check all that apply [Face-to-face, Phone, Email, Video-call, Messaging, Other]

Please tell us about the person you have assisted at the previous question

6. [variable*: relationship*] What is your relationship to the person that you have assisted? [A close friend, a colleague at work, a parent, a grandparent, an acquaintance, other]
7. [*variable: seeker age*] What is the approximate age of the person that you have assisted?
8. [*variable: repeated help frequency*] How often have you assisted the person with the same type of problem? [never-1, once, more than once, often, very often-5]
9. How quickly did you assist that person from the moment you received the help request? [within a few minutes-1, within an hour, within a few hours, within a day, within a few days, within a week, within a few weeks, within a month, within a few months-9]
10. Referring to the help experience that you described above, please indicate below, the best to represent your agreement level for each statement. [Strongly disagree -1, Disagree, Neither agree nor disagree, Agree, Strongly agree-5]:
    - [variable: technological emergency] I felt that the person had a technological emergency
    - [variable: time to solve] Solving the problem had taken me a lot of time
    - [variable: willingness to assist] I will be happy to assist that person again in solving another technological problem
    - [variable: familiar with preferences] Knowing the person's preferences had helped me to solve the problem
    - [variable: exposure concerns] I was concerned that I would be exposed to sensitive personal information while providing help
    - [variable: exposure approval] I think that the person is okay with the information I have seen while solving the problem

Assistance with a smartphone

These questions refer to any help that you have provided with smartphone technological issues:

11. [*variable:* assisting *frequency*] In the last 12 months, how often have you assisted other people with smartphone problems related to privacy and security (such as app permissions and passwords)? Choose the frequency in which you believe you assist them. [scale: never, at least once a year, at least once a month, at least once a week, every day; N/A]: Close friends, acquaintances, colleagues, parents, grandparents
12. [variable*: willingness frequently to assist*] How often are you willing to assist other people with smartphone problems related to privacy and security (such as app permissions and passwords)? Choose the frequency in which you believe you are willing to assist them. [scale: never, at least once a year, at

least once a month, at least once a week, every day; N/A]: Close friends, acquaintances, colleagues, parents, grandparents

13. [*variable:* assisting *attitude*] Choose the best to represent your agreement level for each statement. [Strongly disagree -1, Disagree, Undecided, Agree, Strongly agree-5, N/A]: I am okay to assist [placeholder] with smartphone problems related to privacy and security (such as app permissions and passwords). Placeholder: my close friends, my acquaintances, my colleagues, my parents, my grandparents

General Questions

14. [*variable: altruism*] Please indicate below, the best to represent your frequency with which you have carried out the following acts. [never -1, once, more than once, often, very often-5]:
    - I have delayed an elevator and held the door open for a stranger.
    - I have allowed someone to go ahead of me in a lineup in the supermarket
    - I have given money to someone who needed it (or asked for it).
    - I have done volunteer work for charity.
15. What is the approximate age of the following family members? [scale: Under 45, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, Over 75, N/A]: your father, your mother, your grandmother, your grandfather
16. What is your gender?
17. What is your age?
18. What is the highest level of education you have completed?
19. In which country do you reside?