

# Smartphones, Apps and Older People's Interests: From a Generational Perspective

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## ABSTRACT

It is well-documented that ICT are designed mostly with young users in mind. In addition, most studies about smartphone use do not include older people or even consider age differences. Consequently, little is known about how to design smartphone apps taking older people's interests into account. We have used a mixed-method approach with an intergenerational perspective to approach this topic. First, we track the smartphone activities of 238 panelists. Second, we conduct an online survey (382 respondents). Third, we document the experiences of a group of older people in a smartphone learning club. We have found specific media consumption and communication patterns among older individuals: for example, at home they are more prone to jumping between devices for ergonomic reasons, thus, cross-device interactions are key for this group. We discuss the relevance of intergenerational studies in counterbalancing the spread of age stereotypes and identifying alternative adoption trends.

## Author Keywords

Ageism, age stereotypes, older people, smartphone, use, log data, mixed-methods, tracking, cross-device

## ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g. HCI): User Interfaces

## INTRODUCTION

The emergence of smartphones, with their diverse embedded sensors, along with expansive app markets has opened the door for new Internet services related to communication, media consumption, health and entertainment while on the move. Research can help direct this trend by providing implications for ICT design, but smartphone use studies include mostly young adults (e.g.

[1,4,7,35]). Furthermore, the research that does exist on smartphones and older adults either reinforces age stereotypes (e.g. [21,25,36,43,45,53]) or focuses mostly on compensating for changes due to age-related decline (e.g. [20,21,25]).

Digital media use, as part of mediated communication, is studied widely in regard to children and youth but is underdeveloped when it comes to older people [16]. Teenagers and young people are generations of reference for ICT studies, as they help identify the main adoption and use trends [12]. However, there appear to be (non-explicit) normative claims that the ideal use and adoption patterns are those of the young, which does not take into account that personal values and interests change over the course of a lifetime [40]. More specifically, personal communication patterns and the use of media evolve as we grow older, as Ling, Bertel, & Sundsoy [32] demonstrated in their analysis of differences in SMS use among age groups.

Countering age-related decline is key for older people with severe cognitive and/or physical problems and can help reduce public health costs [22]. However, "the majority of older adults are well enough to live independently" [22:472], have diverse interests [22,24] and want to enjoy life [49,53]. Around age 60, individuals might start experiencing the first social (e.g. retirement, widowhood) or health (e.g. physical and cognitive decline) changes that come with aging. Despite this, most of them are quite healthy, independent and willing to enjoy life. Some researchers refer to them as the "third age" or the "young-old", in contrast to the "fourth age" or the "old-old", who have severe cognitive and/or physical problems that limit their autonomy [26,41]. Ironically, the "third age" and "fourth age" are not associated directly with age so much as a physical and cognitive condition. Thus, the young-old are quite healthy, independent older adults (60+) with special ICT-related needs and interests that should be taken into account when designing new technologies. In this study we focus on these older adults. Taking the interests of older people into account when designing new technologies can contribute to their enjoyment of life and therefore their general wellbeing. Moreover, it can counterbalance the strong influence that youth interests have over the design of new technologies [12].

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We took a mixed-method and generational approach combining quantitative and qualitative data to understand our research question: How do quite healthy older people (60+), enough to live independently and make autonomous decisions, use smartphones differently from other age groups? And can how such information be used in the design of future technologies? To answer these research questions, we registered the smartphone-based Internet activities of a set of active smartphone users, conducted an online survey about smartphone experiences, and attended a smartphone learning club attended by older people.

According to our study, at home, most smartphone club participants opt to use other devices such as desktops or tablets instead of smartphones. Therefore, multiplatform developments are as important as usability for them. In addition, among tracked panelists, the number of apps used increases with the number of app accesses. The greater the number of apps used, the more diverse the use of the smartphone, and vice versa. Thus, we would argue that leisure apps, designed according to the particular interests of different groups of people, play an important role in the appropriation of new devices.

Finally, our results attest to the relevance that intergenerational user studies including older people have in counterbalancing the influence that younger generations have over the design of technologies. Not only that, they are also useful in creating alternative adoption trends related to the different interests people have throughout the life cycle. Our research intends to dispel some of the myths about aging that are often disseminated in HCI.

#### **RELATED WORK**

The HCI research dealing with older people and smartphones either describes the challenges of smartphone **appropriation** processes or how to design and evaluate apps in terms of their ability to **counterbalance declining health due to age**. In terms of identifying implications for design according to user interests, smartphone use studies have been key. Here we provide some examples in this regard.

#### **Appropriation challenges**

Previous studies have discussed the difficulties older people have with the appropriation of smartphones [28,30,36]. According to these studies, older people often receive ICTs (e.g. first mobile phone) as a gift or inherit a second-hand device from a family member [29,43,53]. Family encouragement is the main factor influencing older people's decision to initially accept smartphone use [45,53], and "older populations may not realize the full benefits of available technologies" [18:3] or use mobile phones mainly for basic communication, safety and security reasons [31,36,45]. While the latter situation should have changed with the advent of new smartphones' embedded capabilities, this stereotypical discourse has focused on depicting older people as weak, dependent users, with no criteria on which to make their own informed decisions,

suggesting that such behavior would be exclusively for younger people.

Moreover, most studies about older people's smartphone use focus on new or reluctant users [29,31,36,39,45]. Consequently, they often portray older people as not being avid users or in need of special considerations to counterbalance declining health due to their age. Some exceptions include [22,53].

There are those researchers who argue that older smartphone users appropriate smartphones successfully, if they find it useful [22] or if it contributes to a more social, active, meaningful and independent life [36]. Moreover, they state that appropriation requires the so-called "absorptive capacity", i.e. "prior related knowledge confers an ability to recognize the value of new information, assimilate it, and apply it" [14:128]. This idea, borrowed from economics, can be understood as the background that facilitates the adoption of new ICTs, and we use this concept in order to understand what intrinsic factors of the smartphone experience contribute to an increase in its appropriation.

#### **Compensating for age-related decline**

Most HCI research on older people and smartphones focuses on compensating for the health problems that accompany the aging process by developing special apps for older people [52], for example, apps to help older people manage medication [20]. *Go-myLife* is a social networking platform adapted to the needs of older people [25], and *YourWellness* is an application to support positive emotional wellbeing in older adults [21]. As older participants in various studies often report usability as being the main challenge they face with smartphones [2,36,39], providing guidelines for usable mobile interfaces, such as in [17,56], is relevant in HCI.

#### **Implications for design**

Smartphone use studies contribute to the understanding of life patterns and provide implications for app design that better suit the interests of users. For example, based on smartphone logs of more than 4,000 users, Böhmer et al. provided general implications for smartphone design, which included the relevance of providing "smart links between apps that are used frequently in sequence" [7:53]. Other implications have focused on specific topics, such as implications for the design of smartphone phonebooks, which was studied through an online survey amongst 200 voluntarily participants [5], or the design of smartphones for second-hand use [43]. Implications for the sustainable design of applications were also studied by [35], and, similarly, [23] argued for adapting smartphones to user behavior to predict energy drain.

Regarding use patterns, a study of mobile searches concluded that smartphones, "Rather than pushing us away from the world around us are instead just another thread in the complex tapestry of everyday interaction" [9:1,031].

Other use pattern studies have argued that mobile phones are mostly used at home and with Wi-Fi [42]. Moreover, communication apps (messages, calls and video calls) are widely used throughout the day, while weather or news apps are mostly used in the morning and games or ebooks are mostly used at night [7,57]. A study in Flanders, Belgium, analyzed news consumption on mobile devices, smartphones and tablet computers. News media were consumed on different screens, such as computers, laptops, television or mobile devices. However, the authors found a noticeable shift towards news consumption on mobile devices [19]. Indeed, the mobile phone tends to be used “most from stable locations, such as the home, work, or school” [12], more than on the go [44]. This might be because, comparatively, individuals tend to spend less time on the go.

However, most studies about smartphone use do not include older people, do not report the age of participants, or do not analyze how age and other socio-cultural aspects of participants’ lives could have influenced the results of the study, e.g. [1,4,7,35,38,42,44,57]. Some exceptions include generational studies [1,2]. Consequently, it is possible that the results of most smartphone use studies are influenced mainly by young people and that the interests of older people have not been taken into account in the design of new technologies. Moreover, different interests amongst adults might depend partially, but not entirely, on age. Social, cultural and life trajectories, professional experiences, family contexts and gender are important dimensions [40]. Thus, further studies are required to better understand how to design technologies that take into account the diverse interests that emerge throughout the life cycle.

### Our approach

In our research we have used a different approach. First, we focus mostly on active, older smartphone users. We do this under the assumption that there are active older smartphone users and that they are an increasing population –

particularly in Spain, where these studies took place. This could be due to both the widespread use of smartphones and generational change, as more and more active smartphone users are turning 60+. Active smartphone users can help to understand how smartphones, when successfully appropriated, could be useful among older people. Namely, the information gained from them will help to design ICTs more suited to their interests. Second, we use a generational approach [34] in order to understand how use is different from other age groups.

### METHODS

We adopted a mixed-method approach by combining quantitative and qualitative studies with a generational perspective [33] to address the research question. First, we tracked the smartphone activities of 283 adults during one month. Second, we conducted an online survey, gathering 382 respondents’ answers about their mobile phone experiences. Third, we attended a smartphone learning club, a group of older people who were self-taught in the use of their smartphones, in order to gain insight into the way they used their smartphones (see a summary of the individuals involved in the study in Table 1). In each study we wanted to answer the same research question: How do quite healthy (enough to live independently and make autonomous decisions such as being able to participate voluntarily in this study) older people use smartphones? How do they use them differently from other age groups? We explored such questions through the three studies in order to triangulate data from different sources, specifically: self-reported quantitative data from the survey, logged activities from the tracking system and qualitative observations from the smartphone learning club. In each study, individuals voluntarily accepted to participate and to provide information that would be used exclusively for research purposes, while their privacy was preserved. In the following section, we detail the three studies, outlining those aspects that are relevant for the remaining sections.

	Tracked panelists		Survey respondents		Smartphone club participants		Total	
	Individuals	Women	Individuals	Women	Individuals	Women	Individuals	Women
18 to 24	36* <sup>1</sup> (15.1%)	18 (50%)	49* <sup>2</sup> (12.8%)	23 (46%)			45 (10.8%)	23 (51%)
	* <sup>1</sup> The youngest was 20		* <sup>2</sup> The youngest was 18					
25 to 39	94 (39.5%)	57 (60%)	96 (25.1%)	61 (63%)			120 (28.9%)	72 (60%)
40 to 59	91 (38.2%)	41 (45%)	121 (31.7%)	62 (51%)	2* <sup>3</sup> (6%)	1 (50%)	132 (31.8%)	67 (51%)
					* <sup>3</sup> The youngest was 55			
60 to 87	17* <sup>4</sup> (7.1%)	6 (35%)	116* <sup>5</sup> (30.4%)	47 (40)	31* <sup>6</sup> (94%)	15 (48%)	118 (28.4%)	47 (40%)
	* <sup>4</sup> The oldest was 76		* <sup>5</sup> The oldest was 80		* <sup>6</sup> The oldest was 87			
Total	238 (100%)	122 (51%)	382 (100%)	193 (50.5%)	33 (100%)	16 (48%)	415 (100%)	209 (50.4%)

**Table 1. Description of studies by number of individuals and percentage of individuals by age cohorts, and number of women and percentage of women by age cohorts.**

### **Mobile app tracking study**

We used a market research panel based on the Spanish population to track the online activities of the smartphones of a set of panelists (whom we will henceforth refer to as “tracked panelists”). Tracked panelists had already been registered in the panel when we decided to do the study. The panel had recruited the panelists through direct invitations sent to active Internet users. Having received the invitation, in order to take part, tracked panelists had to install a tracking app on their device(s), receiving non-monetary rewards for participating in the panel activities – mainly surveys and tracking. Non-monetary rewards depended on the level of participation in the different studies, accumulating points to be exchanged for commercial products delivered to the home.

The dataset corresponds to one month of activity between November 17 and December 16, 2014. The software registered the number of times users accessed an app, the date and time of access, the active length of the session and the type of connection (Wi-Fi or mobile data). For example, if a tracked panelist opened a fitness app (i.e. Endomondo) to track their running, the software counted when they activated it as one access, and then logged the length of the session until the tracked panelist moved on to another app or their phone returned to the idle mode.

While we expected to have a sample that would resemble the distribution of the Spanish population by age cohorts, the tracking panel did not have enough older panelists tracked in their smartphones to meet this demand and the oldest tracked panelist was only 76. Therefore, in the end, the number of tracked panelists by age resembles the age distribution of the members of the Spanish population who are active Internet users [27], with older age cohorts underrepresented. Thus, tracked panelists included 238 individuals. There were 116 men and 122 women (48.7%; 51.2%), aged 20 to 76 ( $M=39.03$ ,  $SD=12.9$ ). Thirty-six panelists (15.1% of the sample) could be classified as young individuals or “youth” – 20-24 years old; 94 (39.5%) as young adults – 25-39 years old; 91 (38.2%) as adults – 40-59 years old; and 17 (7.1%), as older individuals – 60-76 years old ( $M=65.41$ ,  $SD=5.316$ ).

While most previous smartphone log studies have analyzed the length of accesses [7,11,57], in this paper we mostly focus on the number of accesses. We saw that the number of accesses was closely related with user activity. Furthermore, the access length was strongly influenced by the idle screen time and the app category (e.g. people usually engaged in short sessions with instant messengers and long sessions with games). Regarding idle time, the tracking systems could not detect if an app was closed by the user or kept open until the phone became idle, which meant that it depended more on the predefined settings than on active use.

### **Survey study**

382 panelists, 189 men and 193 women (49.5%; 50.5%) aged 18 to 80 ( $M=45.94$ ,  $SD=15.776$ ), from the same panel used for the tracking study, answered an online survey (whom we will henceforth refer to as “survey respondents”). It was conducted in May 2015. Out of the total number of all survey respondents, 216 (56%) also participated in the mobile tracking study. Forty-nine panelists (12.8% of the sample) were classified as young individuals or “youth” – 18-24 years old; 96 (25.1%) as young adults – 25-39 years old; 121 (31.7%) as adults – 40-59 years old; and 116 (30.4%) as older individuals – 60-80 years old ( $M=64.61$ ,  $SD=4.679$ ). The sample resembles the age distribution of the Spanish population with an overrepresentation of older people [27]. The survey remained open during one week, and took a mean of 11’20” to answer it, with a 7’15” standard deviation. While all survey respondents were active Internet users, most of them were smartphone users. The survey was provided in Spanish, with an English translation for the purpose of this paper.

### **Smartphone learning club study**

The first author of the paper primarily attended the weekly meetings of a smartphone learning club. Smartphone club participants had different levels of experience with smartphones, from brand-new users to those with three years of experience. Thirty-three smartphone club participants, 16 men and 17 women (52.5%; 48.5%) aged 55 to 87 ( $M=70.5$ ,  $SD=7.7$ ), were involved in the group (we will henceforth refer to them as “smartphone club participants”). When quoting smartphone club participants, we will refer to them by sex and age to maintain their anonymity. Although the group was open and free, all of them were 55+ and most of them were 65+ (66%). Attendance was not compulsory, and each session could involve between 15 and 30 smartphone club participants. They met at Àgora, a highly participative, lifelong-learning community, in order to share their knowledge, resolve doubts, and learn new things from their partners. Àgora is committed to strengthening the social inclusion of individuals in Barcelona (Catalonia, Spain) by providing them with free courses in a wide range of areas, such as the Internet and languages [50].

The group had been running for 24 months, and the first author attended the meetings for over one year, helping to resolve doubts, as a spectator of the debates, and, moreover, to understand the motivations, interests and strategies of a group of active smartphone users by immersing herself in their own community. Thusly, an ethnographic approach [6] was used to explore the topic. Informal interviews were also held during the sessions, discussion sessions and focus groups. In particular, three focus groups were conducted simultaneously with 25 of the learning club’s smartphone club participants. Two researchers together with the first author of the paper conducted the focus groups and their subsequent thematic analysis [8], looking for prominent

topics. Activities were conducted in Catalan and/or Spanish. Notes were taken after the activities and focus groups had been recorded and transcribed. Thus the contents have been translated into English for the purpose of this paper.

*Data analysis, app categorization*

For analytical purposes, we categorized the most prominent apps used by tracked panelists. To optimize the classification process, we reduced the number of apps, selecting them by applying three non-exclusive criteria, namely, the number of users, the number of accesses and the mean time of use. In each case we included the top 300 apps. In terms of users, the app in the 300th position had 4 users, while the top app had 233 (WhatsApp). In terms of accesses, the 300th app had 88 accesses while the top app had 188,911 accesses (WhatsApp). Finally, in terms of access length, the app in the 300th position had a mean access time of 2:57 minutes, while that of the app in the 1st position had 60 minutes (Clean).

We created a preliminary app taxonomy taking into account the different aspects of mass self-communication [13] and media consumption. While previous studies have used adaptations of app store taxonomies [7,11,57], such taxonomies are self-selected by developers [61], and thus inconsistencies can be found, such as similar applications in different categories. For example, Google Translate and Word Reference both be used to translate content, but one is under the category “Tools” and the other is under the category “Books and Reference” in the Google Play Store [59].

In the end, 675 apps were categorized, which represented 30% of all apps accessed by tracked panelists during the study (675 out of 2,247) and included activities from all 238 panelists. The selected apps accounted for 97% of accesses during the study and for 98% of the time spent by tracked panelists on their smartphones. Apps were categorized using an iterative and open form of content analysis. Three researchers used the name of the app and its description, through three iterations, to categorize apps until consensus was reached. While a given app could be related to more than one category, we classified each app according to its more relevant use. Thus, categories, which are mutually exclusive, are described in Table 2.

For the analysis we focused on a selection of categories deemed relevant to the topic of our study: intergenerational comparison of smartphone activities. We excluded the “eBooks” and “Health & Fitness” categories in some of the analysis, as they did not have a sufficient number of tracked panelists to make statistical comparisons. We excluded “System” and “Market Research Tools” in our further analysis, as they mostly constitute activities that the mobile carries out autonomously or are not the user’s intended activity. For instance, launchers in the “System” category were accessed every time the user accessed the device, although the main purpose was to open another app.

Finally, we excluded “Personal Tools” because its wide range of apps returned non-relevant comparisons.

Category	Users	Apps
<b>Bank</b>	72	9
Financial corporations’ apps		
<b>Browsers &amp; Searchers</b>	208	10
Internet browsers and search engines		
<b>Device Management</b>	220	52
Tools for management, improvement, and optimization of the smartphone (antivirus, app managers, battery savers and cleaning systems, amongst others)		
<b>eBooks</b>	34	8
Apps to read and/or download ebooks		
<b>Email</b>	187	10
Apps to manage email, such as Gmail, email (for Android), and Yahoo		
<b>File Management</b>	206	20
Tools for managing files inside the smartphone or with other devices, such as Gallery or Dropbox		
<b>Games</b>	145	171
Games and gambling apps		
<b>Health &amp; Fitness</b>	31	9
Tools to manage data related with health & fitness, such as sport trackers and calorie counters		
<b>IM, Voice &amp; Video Calls</b>	237	20
Apps for instant messaging, phone calls, video calls, SMS or MMS		
<b>Market Research Tools</b>	9	140
Apps to participate in surveys and market studies		
<b>Mass Media On Demand</b>	167	34
Mainstream audiovisual contents on demand, with the exception of apps included in the Radio & TV category		
<b>Media Creator Tools</b>	175	27
Tools for media creation including the camera, voice recorders and apps to edit pictures		
<b>Personal Information Managers</b>	205	28
Tools to manage personal information, namely calendars, contacts, notes, etc.		
<b>Personal Interest Content</b>	125	43
Apps with personal interest contents including catalogues, loyalty programs and scoreboards		
<b>Personal Tools</b>	220	88
Utility tools of general interest including bar codes scanner, tools to download media, flashlights, GPS, educational apps, maps and dictionaries		
<b>Press &amp; Weather</b>	116	23
Mainstream press and weather apps		
<b>Productivity Tools</b>		
Tools for professional performance, including Office Mobile, Polaris Office and QuickOffice		
<b>Radio &amp; TV</b>	68	12
Mainstream radio and TV channel apps		
<b>Shopping</b>	78	24
Apps mainly devoted to sales		
<b>Social Network Sites</b>	225	25
It includes general and specialized social networks sites, as		

Category	Users	Apps
well as social curator systems		
<b>System</b>	37	219
Launchers		

**Table 2. Categories of mobile apps and their description, in alphabetical order. Number of apps and users by category**

## RESULTS

In this section we report the results of the three studies conducted for the purpose of this paper.

### Survey study

While a greater number of older survey respondents did not have smartphones (18.10%) in comparison to other age groups, there were survey respondents of (almost) all ages who do not have smartphones, namely 6.3% of young adults and 4.1% of adults. This result is even more significant given that survey respondents were active Internet users, thus probably more willing to own smartphones than other individuals.

A majority of older survey respondents had bought the smartphone themselves, a similar percentage to the rest of survey respondents, and receiving it as a gift was as common for older survey respondents as for adult or young adult survey respondents (see Table 3).

	Youth	Young adults	Adults	Older people
I bought it myself	59.2%	77.8%	77.6%	79.0%
It was a gift from my family or a friend	40.8%	21.1%	17.2%	16.8%
It is a corporate phone (my company bought it for me and pays the bill)	0.0%	1.1%	5.2%	4.2%
Total	100%	100%	100%	100%

**Table 3. How survey respondents got their current smartphones, by age**

Indeed most survey respondents in all age cohorts bought or received their smartphone mainly because they wanted to have a new phone. Although to a lesser extent, social pressure did account more for older survey respondents' decision to buy a smartphone than in other age groups, and there were more older survey respondents who wanted to change phones because they did not have a smartphone (see Table 4)

	Young Young	Young Adults	Adults	Older Adults
I did not have a smart phone	2.1	2.1	2.4	3.0
My family and/or friends wanted me to have a better phone	2.3	2.1	2.3	2.8
The last one was broken	3.8	3.3	3.1	2.8

(battery, glass or main functions failures)				
I wanted to have a new phone.	3.9	3.8	3.9	3.9

**Table 4: Main reasons for survey respondents to obtain the last phone by age group. Answers were provided with an agreement scale (1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree).**

While older survey respondents have less percentages of adoption of smartphones, laptop computer, ebooks, and smarttv, this is not the rule for all technologies. Concretely, more older survey respondents used tablets (50%) and smartwatches (9%) than younger respondents (46 & 4 % respectively).

Among this list of possible everyday devices, smartphones are the main device for most people in each age group, including older smartphone users (see Table 5).

	Smartphone	Non-smartphone	Desktop computer	Laptop computer	Tablet	eBook	Smart TV or TV with Internet	TV without Internet	Smartwatch
Youth	1	8	3	2	4	6	7	5	9
Young adults	1	7	3	2	4	8	5	6	9
Adults	1	8	2	3	5	7	4	6	9
Older people	1	4	2	3	6	8	7	5	9

**Table 5. Ranking of the most used ICT devices by age cohort**

### Tracking study

According to our tracking study, the older the tracked panelist, the less often they accessed smartphone apps, and vice versa. However, this varied across different indicators. Some app categories were more used by older people than the rest of the tracked panelists. Moreover, as many tracked panelists of all ages used their smartphone most often, and it was used for more diverse purposes. Finally, comparatively, older people used mobile data more often than Wi-Fi, while the rest of the tracked panelists used Wi-Fi more often than mobile data. We will explain these results in the following section.

#### Smartphone use and app use by age

Among tracked panelists, age and smartphone frequency of use are negatively correlated ( $r=-0.190$ ,  $p < 0.0$ ,  $n=238$ ). Furthermore, some app categories are comparatively more popular among some age cohorts. Figure 1 gathers the age distribution of active users in each app category, in terms of average accesses per tracking panelist. There are significant differences between accesses per day and age for some app categories.

- “Mass Media On Demand” shows a negative correlation ( $r = -0.155$ ,  $p < 0.05$ ).
- “Press & Weather” and “Personal Information Manager” positively correlate with age ( $r = 0.189$ ,  $p < 0.01$ ;  $r = 0.112$ ,  $p < 0.1$ , respectively).
- “Personal Interest Content” is more popular among those between 60 and 76 years of age than among young adults and adults (ANOVA test,  $p < 0.05$ ).
- “IM, Voice & Video Calls” and “Social Network Sites” show a negative correlation between the accesses per day and age ( $r = -0.243$ ,  $p < 0.001$ ;  $r = -0.138$ ,  $p < 0.05$ ; and  $r = -0.155$ ,  $p < 0.5$ , respectively). However, those categories are the first and second most-used categories respectively for each age cohort, including older people. Older tracked panelists accessed such categories less often, just as they accessed their smartphones less often.

**Absorptive capacity**

While we cannot assume any causality direction between the number of apps and the number of accesses, we have proven a one-tailed Pearson correlation among the two variables. According to the Pearson correlation, the greater the use of the smartphone, the more diverse the uses, and vice versa (see Figure 2). Thus, there is a correlation between the number of used apps by each tracked panelist ( $M = 38.87$ ,  $SD = 17.454$ ) and the number of app accesses (92 app accesses per person, per day,  $SD = 71.353$ ),  $r(220) = 0.570$ ,  $p < 0.001$ . This is also true within each age cohort; youth ( $r(32) = 0.628$ ,  $p < 0.000$ ), young adults ( $r(87) = 0.636$ ,  $p < 0.000$ ), adults ( $r(85) = 0.515$ ,  $p < 0.000$ ), and older people ( $r(16) = 0.559$ ,  $p < 0.05$ ) (see Figure 2).

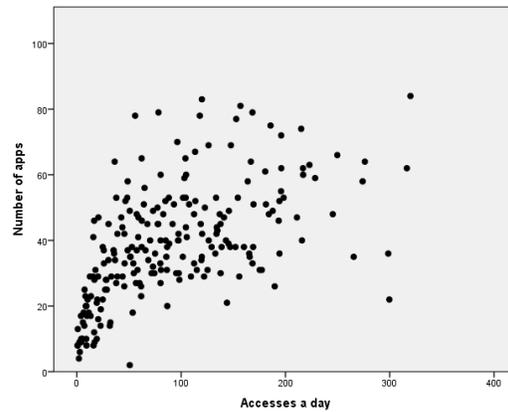
Similarly, amongst tracked panelists with Wi-Fi and mobile data connections, there is also a correlation between the number of Wi-Fi accesses and the number of mobile data accesses by user ( $r(203) = 0.306$ ,  $p < 0.000$ ). This is true also within three age cohorts; youth ( $r(32) = 0.702$ ,  $p < 0.000$ ),

adults ( $r(81) = 0.217$ ,  $p < 0.05$ ), and older people ( $r(11) = 0.625$ ,  $p < 0.05$ ). Those that used their Wi-Fi connection more often also used their mobile connection more often, and vice versa.

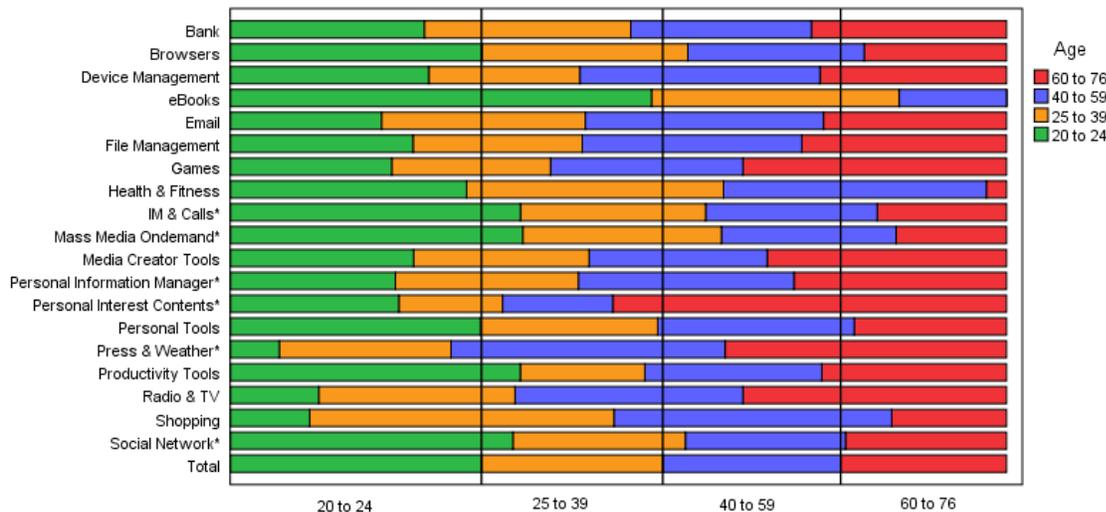
**The ecology of devices from older people’s perspective**

As we explained above, age and smartphone use frequency are negatively correlated ( $r = -0.190$ ,  $p < 0.0$ ,  $n = 238$ ). However, amongst all tracked panelists with Wi-Fi and mobile data connections, Wi-Fi was significantly more commonly used than mobile data connection (mean accesses per day of 54.6 and 42.3, respectively).

There are no significant differences in the mean accesses per day using a Wi-Fi and mobile data connection among older tracked panelists (35.0 and 35.1, respectively) (see Table 6). Thus, comparatively, older people use smartphones less often with Wi-Fi but similarly to other age groups with mobile data.



**Figure 2. Number of accesses per day and number of apps by tracked panelists**



**Figure 1. Age distribution of active tracked panelists by app category, in terms of mean accesses by individuals. (Active panelists are those with one or more access to a given category.) \* Statistically significant differences among age groups.**

Age	20-59	60-76	20-76
Accesses per day (Wi-Fi or mobile data)	98.9	70.2	96.92
Wi-Fi accesses per day	56.1	35.0	54.6
% of Wi-Fi accesses	56.6%	49.9%	56.3%
Mobile data accesses per day	42.8	35.1	42.3
% of mobile data accesses	43.3%	50.1%	43.6%

**Table 6. Mean accesses per day by device connection for tracked panelists in two age cohorts**

### Smartphone club study

The reports from the smartphone club participants challenge some common age stereotypes, including that they are less avid users of technologies, that they are passive receivers of technologies or that ICTs are intended to compensate age-related decline. They can also confirm or question the results of the tracking study.

#### Becoming smartphone users

Two smartphone club participants reported on their late smartphone appropriation process, as they were among those who accepted having a smartphone later on. While they were initially reluctant to own a smartphone, with continued use they saw some benefits.

*I didn't want to have a smartphone, because I don't trust objects. (Man, 69)*

*I didn't need to have a smartphone, because my husband has his all the time. (Woman, 60)*

As they gained experience they changed their mind and found it useful:

*I was initially reluctant to have a smartphone [...] I ended up owning a smartphone by mistake, somebody else didn't want it [...] I only use the smartphone when needed, and to check all the rubbish people send through WhatsApp. (Same man as above, 69)*

*The smartphone was a gift from my husband [aged 60] who was tired of me not having WhatsApp. Now I really enjoy having my grandchildren's pictures at hand. (Same woman as above, 60)*

#### The senior techies are here!

Moreover, some smartphone club participants reported being technology fans:

*You know, I explore everything. I do not give up until I know everything about a new app. (Man, 76a)*

*I went to the store to buy a new smartphone, I wanted to have a better one, and they stared at me like, "Why would this old woman like such a smartphone?" Everyone is*

*free to have a desire and this was my desire. (Woman, 76)*

#### Smartphones as a gift

Although a significant percentage of survey respondents of all ages received the smartphone as a gift from close acquaintances, gifts are not always a surprise or deliberated action dedicated to a passive receiver, as reported by one smartphone club participant:

*I told my children to give me a new smartphone for my birthday, but they always want to give me a trip. I don't know what they are going to do this year. (Woman, 70)*

#### Wi-Fi or mobile data? At home or on the go?

Smartphone club participants reported using Wi-Fi mostly at home or in their everyday locations, while they use mobile data on the go:

*I use Wi-Fi in my everyday locations, where I already have the password and it connects automatically; otherwise I use mobile data. (Man, 76a)*

*For the half hour you are going to be in a bar there is no need [to connect to the bar's Wi-Fi]. (Man, 69)*

Public Wi-Fi accesses turned out to be relevant when on a trip, while accessing public Wi-Fi on the go in their hometown is not common practice:

*I don't even try to connect to public Wi-Fi accesses, except when I'm on vacation. (Man, 73)*

Smartphone club participants reported that at home they prefer to change from smartphones to other devices, namely the tablet or the computer:

*I talk with my daughter on Skype. I answer on my smartphone, and then I prefer to change to the tablet. (Woman, 77)*

*I use the smartphone to filter uninteresting emails before changing to the computer to continue with the interesting ones. (Man, 64)*

They use the smartphone at home when it provides new options:

*I use the smartphone in the kitchen to listen to the radio. (She has no radio in the kitchen) (Woman, 61)*

Abroad they use the smartphone as a solution to access services they cannot access because they do not have the facilities they have at home:

*I install the Facebook app when abroad. (Man, 64)*

#### Technology to support personal interests, not only needs

Beyond basic communication, security and safety reasons, smartphone club participants reported using their smartphones to support their diverse personal interests, including social interaction, personal management, cultivating a hobby and entertainment:

*I think it is a tool to bring joy to people... [A woman interrupts to say Yes, I'm sure] ...to break the monotony.*

*Whenever I receive a nice WhatsApp, I forward it immediately; I want others to enjoy it. I do not want to be the only one who can enjoy it. (Woman, 81)*

*These (WhatsApp) groups are both the most useful and most useless tool you can find. (Man, 68)*

*I take a picture of my grandchildren, then I put a frame on it, and I send it. It is so entertaining. (Man, 78b)*

While access to media creator tools by older tracked panelists did not particularly stand out in the tracking study, smartphone club participants reported great enthusiasm for all activities related with pictures, that is, taking, editing, sharing and seeing each other's pictures.

*I use it [the smartphone] for pictures, WhatsApp and to call. (Woman, 81)*

*I love photography. During a trip I take all the pictures with my smartphone, then, when I come back, I download the picture and make a video with music on the computer. And then I send it to the friends we shared the trip with. (Man, 76b)*

According to the tracking study, the use of personal information manager apps increases with age. However, smartphone club participants reported fairly diverse uses of digital and analog personal information managers, integrated with their everyday life:

*A short time ago, I decided to use the phone to remember everything – medical appointments, pills, shopping list and family agenda. (Woman, 77)*

Personal interest content apps were especially interesting for older tracked panelists, showing the diverse uses they make of smartphones. Smartphone club participants reported:

*I use it for inquires while reading; I like Spanish history so I watch videos on the smartphone. Then, I like poetry and on the smartphone you can see the meter in a verse. (Man, 78)*

*I read the sports newspaper in the morning [...] I use it to follow the football match abroad" [...], and I use the app Seient Lliure [to manage his football season ticket]. (Man, 76b)*

*I use it to check the cinema listing, and to share recipes with my friends. (Woman, 70)*

Finally, the "Press & Weather" category was especially popular among older tracked panelists; "Social Network Sites" was their second most-used category. Smartphone club participants, who were habitual users of social network sites such as Facebook, did not report being very enthusiastic about them. Probably the novelty effect of such tools has passed and nowadays there are other trending topics for discussion about smartphones.

## IMPLICATIONS FOR DESIGN

From these results, we provide two main implications for designing new technologies. First, taking into consideration the smartphone usage patterns of the tracked panelists and

reports from smartphone club participants, **cross-device interactions** are relevant and more developments are required to impact everyday life. Second, to facilitate the appropriation of new services, it would also be relevant to embed such services in **everyday devices** or add different leisure apps according to the interests of people on brand new devices. We will explain why in the following paragraphs.

### Cross-device interactions

While previous studies argue that mobile phones are mostly used at home and with Wi-Fi [42], smartphone club participants prefer to use more "comfortable" devices (i.e. not smartphones) at home. They use mobile data mostly while outside the home or their everyday locations. At home, they prefer to change the smartphone for other devices.

Contrary to the general tendency, older tracked panelists used their smartphones with Wi-Fi as much as mobile data. Thus, proportionally, they used it more with mobile data than other age groups. Thus, we could argue that older tracked panelists used their smartphones less than the rest of the tracked panelists, partially due to their preference for using other devices at home, while other age groups should have made extensive use of the smartphone at home.

Thus, while a big part of ICT literature on older people focuses on accessibility and usability [2,51,55], usable apps will not keep users on their smartphones if they prefer to use more comfortable devices whenever possible. Thus, better supporting the transition of one application across different devices through cross-device interactions is as relevant for smartphones as are usability guidelines.

Cross-device interaction is common nowadays both in research [14,48,58] and in commercial products, e.g by making the data accessible through different devices, (e.g. Chrome, Dropbox). However, more effort is required in terms of cross-device tasks. Namely the transition of one task between two devices often could be simplified; e.g. the process of starting an email (or any other task) in the smartphone and finish it in the computer can be simplified. This could be achieved by synchronizing the current display of the (email) interface, or by allowing users to remotely control with one device the session of a second device, which is not common between smartphones and desktop or laptop computers.

### Everyday devices

Among older tracked panelists' activities we saw that the more the smartphone was used, the more diversely it was used, and vice versa. In addition, older survey respondents who were active Internet users showed high levels of acceptance of new technologies, above the average for the Spanish population [60]. Thus, it seems that having enough "absorptive capacity" [15], which can be interpreted in this context as being able to understand and appropriate a concrete technology, increases with previous experience. In

addition, according to smartphone learning club participants, they use smartphones actively mainly when smartphones are able to support their personal interests. Thus, there is a greater chance of appropriating new services if they are embedded in everyday objects. Therefore, new devices must be endowed with diverse apps that support the particular leisure interests of older people in order to increase their opportunities for device appropriation. Appropriation will ensure that older people keep new devices on hand, when needed for health or security reasons.

## DISCUSSION

Our findings agree with previous authors who argue that older people do not want to use special technologies designed for them [51,53]; none of the individuals in the studies reported using special technologies designed for them; all of them mainly used popular apps.

The evidence shows that **there are older people who are active smartphone users**, as the majority of older survey respondents bought their last smartphone themselves because they wanted to have a new smartphone and because it was their main communication and media consumption device. Therefore, we encourage approaching older people from non-assistive, non-paternalistic perspectives. Moreover, according to our survey respondents, people of all ages receive smartphones as gifts (new or second-hand) from relatives or friends. While both practices have been previously associated with older people, giving a gift is a widespread and complex cultural practice which implies social interaction and reciprocity [37], and inheriting ICTs is mostly associated with low-income contexts (some examples include [10,29,43]), not only with older people. Furthermore, while the literature often reports that older people are late adopters of new technologies (e.g. [46,47]), in the case of our survey, we can argue that digital literacy, in this case by the fact that survey respondents were active Internet users, contributes to the early adoption of new digital technologies. Thus, in this case, early adoption is related more with having a positive view of technologies than age.

We have shown how tracked panelists and smartphone club participants, going beyond basic communication, safety and security reasons [31,36], also used smartphones to cultivate their personal interests, including social interaction, personal management, cultivation of hobbies and entertainment, all closely related with the goals of communication suggested by [3]. While previous research has highlighted that older people have barriers that prevent them from using smartphones [31,39,54], we highlight that smartphone club participants overcame these barriers with their motivation to keep in touch with their relatives, to keep up-to-date with the world's evolution and to expand their personal interests.

While young people are the main reference for the development of new technologies [12], older people are

taken into account merely for special technology designs [22,55]. As it is evident that smartphone interests change throughout the life cycle, we would be proponents of generational user studies that include older people to help identify **alternative trends of adoption and use** that could lead to the design of multi-age smartphone apps. Such alternative trends could match the interests of people of different ages, because interests change subtly across ages. Conversely, user studies focusing only on older people could end up favoring the myriad of age stereotypes, as we demonstrated with the inheriting and gift-giving practices, often disseminated in HCI [22].

For this study, we relied on our preliminary app taxonomy. While this should be further validated, at this stage at least, the app taxonomy solves the inconsistency problems of app store taxonomies, in addition to responding to our research interests, which include mass self-communication and media consumption. Moreover, the tracked data included only 17 older panelists, which is a limitation of the results related with the tracked data. Otherwise smartphone club participants are highly interested in smartphones, and willing to learn more about. While they do not represent the majority of older people, they represent a new wave of older people digitally connected, which will be bigger in early future.

## CONCLUSION AND FUTURE WORK

We have approached the topic of how older people use smartphones from an intergenerational perspective by means of a mixed-method approach. This approach has allowed us to provide two implications for design: including the relevance of cross-device interactions, and the need to embed new services in the everyday objects of users, or the need to provide apps that support different leisure interests in order to facilitate the appropriation of new services.

Our results are preliminary. They need to be validated by means of representative research or similar case studies in different contexts. However, our results could also spark new research ideas and design opportunities among the HCI community, in particular in terms of supporting the diverse interests that can arise over the course of a lifetime. Research that looks at multiscreen uses could contribute to a wider understanding of the subject. Such research could consider such questions as: What are the most common multiscreen uses among older people? Do older people show differentiated patterns of multiscreen uses compared to other age groups?

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