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Abstract	We analyze smartwatch use from an intergenerational perspective to garner non-stereotypical reflections on ageing. The research questions are: (1) How do personal interests shape, and how are they shaped by, first-time use of a smartwatch? (2) To what extent do tracked data help in interpreting the relationship between the user and the device? We analyze two older and two middle-aged adults involved in a one-year case study, and combine log data and reported activities for richer empirical evidence. The older adults showed higher levels of smartwatch activity than the middle-aged The key services they used were notifications and the pedometer. We found that smartwatch uses and forms of appropriation are as diverse as the four participants are and that the ways in which such watches are adopted are shaped by personal circumstances and interests. The tracked data helped to illustrate smartwatch uses, providing acceptably accurate pictures of activities. However, the low number of participants in the case study magnified the data's limitations, which illustrate issues to be taken into account when working with tracked data – or big data in general.

Keywords (separated by '-')	Smartwatches - Log data - Older adults - Middle-aged adults

My Interests, My Activities: Learning from an Intergenerational Comparison of Smartwatch Use

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1 Introduction

With the release of Android Wear and smartwatches by several big brands, including LG, Samsung and Motorola, 2014 was the year of the wrist revolution. There was quite a bit of expectation about how this wearable would allow the public to access and interact with personal information. The first results regarding smartwatch usage began to appear in 2015 (e.g. [1–4]), but these studies have not included older people nor have they made a generational analysis of the data. Following a common strategy in ICT studies, teenagers and young people constitute the reference generations, as they help identify main trends of adoption and use [5]. However, this negative correlation between age and ICT use, so persistent in digital divide studies [6], reinforces older people being overlooked. The increasing demographic and social importance of older people in Europe and other developed countries [7], together with the heterogeneity of older people [8, 9], should lead us to question this traditional approach. Of particular interest from among this group of older people are the active ICT users making specific use of digital technologies (e.g.

[10, 11]), and we should not ignore them if we want to have an accurate picture of the ways our societies – as a whole – appropriate digital technologies.

Thus, in this study we address the issue of how older people use smartwatches from a generational perspective [12], in order to garner non-stereotypical reflections related to age. To do so, we analyze the experiences of two older adults and two middle-aged adults using smartwatch logs along with five interviews over the course of 12 months. Specifically, we used tracked data as material during the later interviews to spark discussion about user experiences. Therefore, beyond trying to provide descriptive statistics of smartwatch usage, as is common in big data analysis, we present in this paper the dialogue between tracked data and user experiences.

Multipurpose digital devices such as the smartwatch offer a set of possibilities that users adopt if they match their individual interests. Thus, in this study we approach two main research questions regarding this new digital product:

RQ1. How do personal interests shape, and how are they shaped by, first-time use of a smartwatch?
RQ2. To what extent do tracked data help in interpreting the relationship between the user and the device?

2   Related Work

Back in the 1990s, wearables were visualized as an opportunity to access personal information on the go, thus acting as "visual memory prosthetic(s) and perception enhancer(s)" [13] p. 23, capable of changing cultural concepts of everyday life [14]. However, since the irruption of different smartwatches onto the market in 2014, few studies on smartwatch use have been able to validate such an assumption. Similar to users of conventional watches [15], style-based choices constitute a relevant part of the smartwatch experience [1, 2]. Most studies highlight the use of notifications, fitness apps and – more recently – GPS [1–3]. Some users question the limited features of smartwatch apps compared to smartphones [1], and, similarly, [3] reports on the interest of users in replacing their smartphone with a smartwatch. While early studies argue that it is faster to access a wrist-mounted device than a device stored in the pocket [16], recent studies go even further, saying that smartwatch notifications distract less than smartphone notifications [3] and that they reduce smartphone dependency [2]. However, accessing smartwatch notifications while driving present no less of a risk as accessing smartphone notifications [4]. None of these studies includes older people or make an intergenerational analysis. Therefore, as of yet it is not possible to know if smartwatches have different meanings for users of different ages.

Most of the research on smartwatches in the field of human-computer interaction (HCI) focuses on new interaction paradigms, showing how smartwatch design is a vibrant area under development. Some examples include: exploring the interactive design within the limited space available on a smartwatch screen [17, 18]; exploring gestures to interact with a smartwatch, including beating gestures [19] and spatial gestures [20]; the limits of tactile patterns [21] or proximity-based hand input [22]; and exploring text input [23, 24] – for example with crowd-assisted writing [25]. A few other

studies focus on the design of new smartwatch apps, e.g. for scratch recognition [26]. Again, these new interaction paradigms and smartwatch apps do not consider older people's interests and do not include older people in their conceptualization, design or evaluation.

Some of the problems for which wearable technologies are seen as a possible solution are often related to older people, such as managing emergencies, controlling health indicators, encouraging physical activity or fighting isolation. Some smartwatch developments give accounts of this trend, e.g. regarding homecare [27] and fall detection [28]. We suggest adopting a broader outlook in order to see how smartwatches can be connected to personal interests and activities and to understand to what extent such technologies are appropriated at different ages.

3 Empirical Data and Methodology

The empirical evidence presented here comes from a case study originally designed to analyze the processes of smartwatch adoption and appropriation by older people during one year. We provided a Moto G 360 smartwatch to participants, all of whom had to have a compatible Android smartphone. Participants had to be 65 or older. They needed to be active users of smartphones already, demonstrate strong engagement to follow the study, and not have a smartwatch. They could choose between the Moto G 360 1st generation (1.6'' screen) and the Moto G 360 Sports 2nd generation (1.37'' screen), models available on the market during the initial recruitment process. Participants received monetary compensation for time spent in interviews and will be able to keep the smartwatch at the end of the fieldwork. Following approved ethical protocols, participants could stop their collaboration with the project at their convenience.[1] Some members of the research team also started wearing the smartwatch to better understand, on the one hand, its affordances and limitations and, on the other, the actual meaning of the log data to be collected. This gave them the opportunity to analyze their experience as users under conditions similar to those of the senior participants. We inserted ourselves in the collection of data and our personal experiences with the smartwatch are included in our interpretation of the results, taking an analytical ethnography [29] approach.

We adopted a mixed-method strategy by combining quantitative and qualitative methods [30] in a flexible design [31] to address the research questions. On the one hand, we collected the smartphone logs. To do so, we developed and launched the Wear Monitor app on Google Play [32], which works with Android watches. All partakers installed it as part of their commitment to the project. To respect privacy, users could stop the tracking app for a period of time, at their convenience. The logs were periodically uploaded to our university server, where the information is securely stored. Among other features, Wear Monitor collected the date and duration of smartwatch app activities as well as the geolocation of these activities, if available. It also tracked if the phone

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[1] In fact, two participants in Barcelona left the project at the beginning of the fieldwork and were immediately replaced.

was connected to the watch during each activity, and what kind of Internet connection the phone was using at that moment. Transmitted information, such as text or images, was not collected to respect users' major privacy issues. When the app was installed, a short survey collected basic demographic information including age, gender and level of education.

On the other hand, we conducted five semi-structured interviews, one every two or three months, with participants. We also provided some training sessions and offered support if they had problems with the wearable. The first semi-structured interview, conducted before the device was delivered, revolved around the expectations created by the smartwatch. The second and third interviews looked at smartwatch use in everyday life, once the participants had increased their level of experience with the smartwatch. The fourth and fifth conversations, conducted once enough log data had been collected, established a dialogue between the tracked logs – depicted as figures or geolocated maps – and the perceived and reported use of the smartwatch.

Partakers could decide when not to wear the smartwatch. The older participants could share the smartwatch with whomever they decided, while the middle-aged researchers shared it within the team or with technicians for exploratory purposes (i.e. to conduct specific observations or to address particular technical issues).

Tracked data were analyzed with basic tools, mostly the graphical depiction of time series (the daily activity of the smartwatch, average accesses per hour or geo-located activities, among others). In the two last semi-structured interviews, we discussed a set of figures with each participant to determine to what degree they identified with the personal information gathered. In preparing this paper, the authors read and reread the interviews with participants, transcribed verbatim, and conducted a thematic analysis [33] to identify common topics relevant to the research questions. The comments received from participants during the recruitment process, training sessions and personal support were also taken into account. The researchers followed a similar strategy to reflect on their own data. They took notes of their experiences with the watch and shared them with the rest of the team in different meetings. Of particular interest for this paper were the design of the figures we discuss in the next section and the subsequent validation of the data based on the researchers' experience.

The smartwatch users involved in the research project were, on one hand, nine older adult participants: four women and five men aged between 65 and 80 at the beginning of the study (average age 71.3, standard deviation 4.7). On the other, four middle-aged researchers: all of them women between 38 and 44 (average age 41.0, standard deviation 2.1). Fieldwork, conducted in Barcelona and Rome, was carried out over a little more than a year between winter 2015 and winter 2016/7 and was drawing to a close at the time we write this paper.

This paper focuses on the smartwatch experiences of four users, two older adults and two middle-aged adults, all living in Barcelona, to get more detailed nuances, enrich the analysis and inspire further analysis. Focusing on this small subset of partakers allows an in-depth investigation of the ways (if any) the smartwatch shapes – and is shaped by – personal interests and everyday life activities. Also, this reduced sample favors a critical analysis of the tracked data's potentialities and limitations to identify the activities conducted with the wearable. Neither the case study nor the subset is meant to provide

representative data, but rather to create a discussion supported by substantive empirical evidence: it is an explorative study. This strategy looks for non-stereotypical reflections related to age, as we understand this is one of the most powerful outcomes of intergenerational comparisons.

The four users we reflect on in this paper are: Carme (female, 80 years old; secondary education); Pedro (male, 70; primary education or lower), who participates in the interviews together with his spouse, Rosa (female, 65, primary education or lower); and Irene and Laia (females, 41 and 44; university degree or higher). We use fake names to guarantee anonymity. In quotations, we will indicate the number of the interview preceded with an "i" (i.e. Pedro_i2). For log data analysis we selected a 3-month period, from March 1st to July 31st, five months after starting to use the watches, when partakers had already surpassed the first stages of use and, therefore, had reached more stable use in everyday life situations.

4   Results and Discussion

4.1   Perception of Use and Activities

In her 80s, **Carme** is a very social person with a fairly busy agenda during weekdays and weekends. Among other activities, she regularly attends different courses and works as a volunteer. She also has an extended personal network – family and friends – with whom mediated communication is essential.

When it comes to talking about digital technology, she loves being up-to-speed with the latest trend and being told that she acts much younger than her age. Regarding the smartwatch, she reports:

Carme_i5: *With the nephews, you feel a little bit conceited, full of yourself. [I tell them,] "What do you think? That you know a lot?" They tell me, "You are not the typical 80-year-old woman," and this makes me feel good.*

During the selected period of tracked data, Carme's smartwatch reported logs for less than half of the days (42%). She did not use it during some holidays in the beach or without internet access, and afterwards some days when it was not working properly. However, on the days she used the watch, she seemed to show the highest level of engagement, with 134 interactions per day on average (see Table 1 and Fig. 1). To her, wearing the smartwatch became "a force of habit… it goes with me". However, although she is the person who seemed to interact more frequently with the smartwatch – when she wears it – she does not think she uses the device too much. According to her, this result must have to do with the fact that she wears it many hours a day, and that she has a lot of incoming notifications from her social circle. Indeed, she explains how she handles notifications:

Carme_i3: *It's not that I use it too much. I mean, I don't get obsessed, but I use it. … Yes. Also, when you get used to it, it's convenient, because suddenly, a beep. Let's see. What's that? Is it an email, a WhatsApp? … And then, well, it's a WhatsApp, then you go to the phone and answer, if you have to answer… That's it… It's practical.*

Table 1. Daily use of the smartwatch during the selected 3-months period

	Older adults		Middle-aged adults		
	Carme	Pedro	Irene	Laia	Average
Smartwatch use, days (N)	39	92	43	73	61.8
% of used (days)	42%	100%	47%	79%	67%
Interactions per day (based on N)					
Average	133.8	84.9	84.6	58.7	84.3
Standard deviation	48.8	28.2	62.5	34.6	47.5
Median	128	82	79	56	81
Min.	5	28	1	1	1
Max.	241	175	264	134	264

Older adults
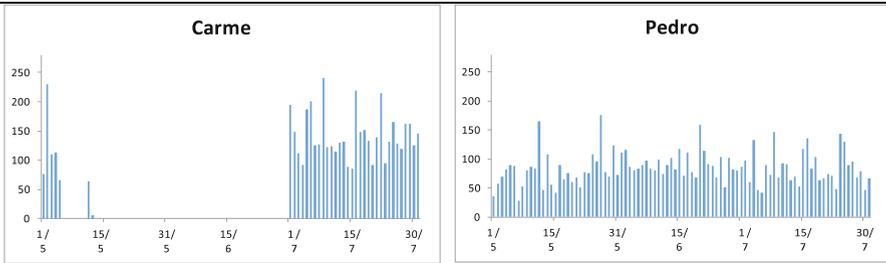
Middle-aged adults
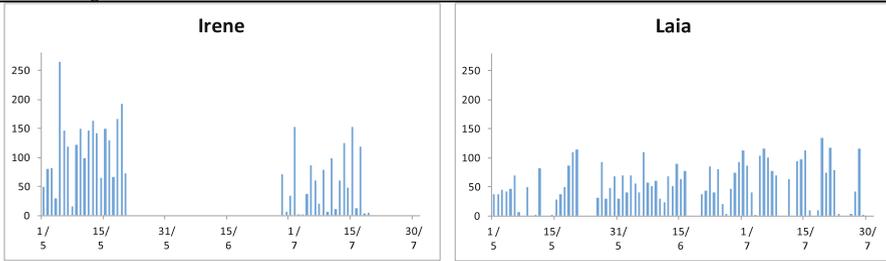
Fig. 1. Smartwatch, number of daily activities during the selected 3-month period

Finally, even though she "always wear[s] it", she clearly states that there are times when she would not put it on. The moments she would opt to wear a conventional watch include, firstly, when she wants or has to dress up; secondly, on vacations when she will not have Internet access; and thirdly, when the smartwatch disconnects from the smartphone and she will have to wait for more than a day to have a Wi-Fi connection so she can pair them up again.

Pedro, 70 years old, loves watches. He likes being in control of time. He and his wife Rosa liked the idea of participating in a technological project and using a new digital device while helping us, the researchers, to fulfill our goals. They share a smartphone,

so when Rosa received the smartwatch, they decided Pedro would be the one to wear it. They also agreed that Rosa could "play" with the device whenever she wanted.

The arrival of the smartwatch changed their daily dynamic. Pedro has a great deal of stamina, and it is important for him to take long walks. He has a long walk in the city every morning, Monday to Friday, and Rosa is very open about how this is a must for him. He used to bring the mobile phone with him so he could track his walks, but as the phone was so big, they decided he could just wear the smartwatch instead. Now during his morning walks Pedro has no way of communicating with home – something Rosa is not happy about – but he has been able to ensure two very important aspects: control over time and control over his physical activity. He explains how he likes checking the number of steps every day and looks to see whether the same path on a different day results in the same step count. He is proud to explain how much he walks, and the number of steps he has taken has become part of his everyday discourse about his activities, as he describes in the second and third interviews:

> Pedro_i2: *What do I do with the watch? Me, what I do the most is [heart]beats and the walking thing [pedometer]…*
> Pedro_i3: *Look.*
> Interviewer_i3: *Today… Eighteen kilometers?! … Where have you gone today?*
> Pedro_i3: *To [Place A].*
> Rosa_i3: *… Like almost every day.*
> Pedro_i3: *There are 18,248 steps… In 2 h and 15 min. … Which is seven thousand-something per hour.*
> Rosa_i3: *No, no, he always has the watch ready… He tells you… the steps he takes: "Today I went through here, and the steps are the same as through there."*

Pedro is the partaker who most regularly wore the watch during the observed period (100% of total days Table 1 and Fig. 1). With 85 interactions per day on average, he is the most regular user of the smartwatch (as he shows the lowest standard deviation, 28.2). He explains he is committed to the project because he and his spouse gave their word and are happy to help us, the researchers. Also, he likes the smartwatch. Not only because he has always worn a watch, but also because he can track his physical activity with the pedometer. Therefore, he would not take off the smartwatch even if it disconnected from the smartphone because although he would not receive notifications he would be getting relevant information all the same.

The two middle-aged adults, Irene and Laia, are the enthusiastic researchers who designed the case study. They were partly inspired by their notion that it would be interesting to have a smartwatch and explore the use of a new digital device. **Irene** in particular felt that wearables would allow for a more natural interaction with information, expecting to be able to carry out the activities she usually did with the smartphone without having to hold a device in her hands. Irene, just like Carme, had a vacation during the observed period. This, together with a work trip during which she had limited access to a plug adaptor to charge the smartwatch, resulted in her using it 47% of the days (Table 1 and Fig. 1). Her number of interactions per day, 85, is similar to Pedro's but she shows more extreme values of use (standard deviation above the average, 63). This could be because, even though on some days she was not wearing the watch, it kept receiving notifications when it was close enough to the smartphone to connect to it.

Finally, **Laia** ranks second in wearing the smartwatch (79% of total days, Table 1). Laia started to use the smartwatch's pedometer and found it an interesting feature. She liked having the notifications on her wrist, as this allowed her to "ignore" the smartphone without missing any important incoming communication. While she found some of the new features convenient, Laia started wearing the smartwatch on and off – more often at the end of the period. She had issues with the watch battery, which drained very often. On these occasions, she would either leave the watch at home – this would happen mainly during weekends – or wear it even though it was off and charge it once she got to a place with a plug – usually the office or home. In fact, she had been asked more than once about the "black-screen watch" she was wearing and had to tell the person asking that the watch had lost its charge, which led to further (negative) comments.

She defines herself as "lazy" when it comes to keeping the smartwatch running, which could explain why she has the lowest number of interactions (59 per day of use, Table 1). In addition, Laia did not feel it necessary to wear the smartwatch during the weekend, even more so if she stayed at home. In terms of the daily activity of her smartwatch, this led to her having scattered zero values close to columns with very low values (Fig. 1). Based on what we learned during our fieldwork, columns with values close to zero typically respond to days on which the watch's battery was drained or the watch was turned off after midnight followed by at least one day in which the smartwatch was not turned on. Laia used to shut the watch down at night because she would put her smartphone on airplane mode. As she did not expect to have to use it, it made sense to go for this small, environmentally friendly gesture.

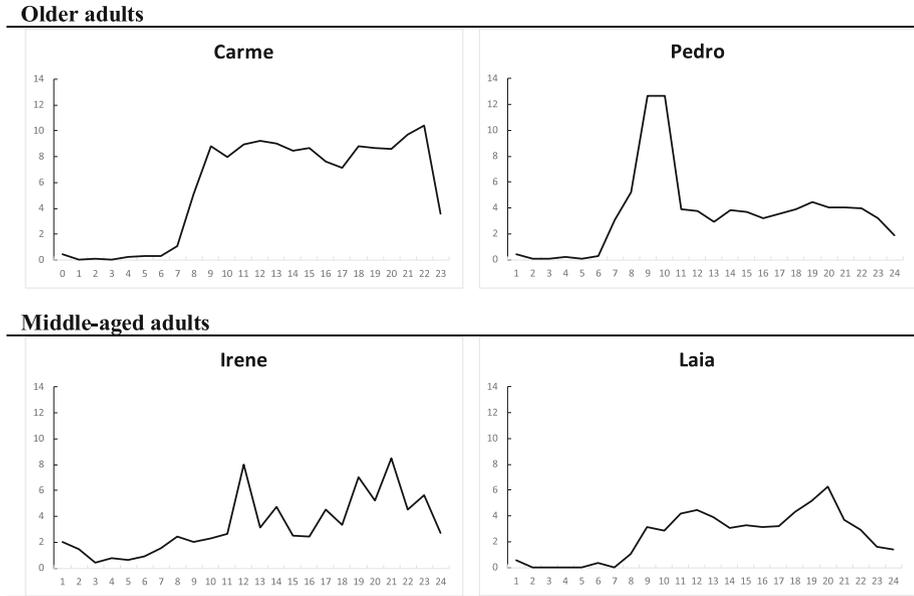## 4.2 Hourly Distribution of the Smartwatch Activities

We explored and commented on with participants the hourly distribution of the smartwatch activities (see Fig. 2). The figures give a sense of the activity engaged in during the day and provide clues about how time is arranged socially – with less activity at night and, in some cases, during lunch time. They depict the average hourly smartwatch activities for each participant. **Carme** told us that she took off the smartwatch at night and left it outside the room, next to the charger. She would charge the watch when she got up, and after her morning routine – which included some physical exercise – she would put the watch on. The hourly distribution of Carme's smartwatch use is consistent with the fact that, out of the four partakers, she is the one who most interacts with the device.

Pedro and Rosa found that the figure reflected his activity:

Pedro_i4: *Me, when I check it the most is when I go walking, [I do it] every now and then … I usually check it when I get to [place B]… And then when I arrive to [place A – his final destination]… There … I check the time it took me … and the steps to get there.*
Rosa_i4: *And then, all the days it is the same… time. … When he gets home he shows it [the smartwatch pedometer] to me… This is why I say that, yes [we recognize ourselves in the figures], because [he usually would go] "look how much I walked today".*

Irene also felt that the figure reflected her activity both night and day. At night she kept both the phone and the watch turned on. Thus, the nighttime smartwatch activity should be due to the incoming notifications she receives while sleeping. She indicated
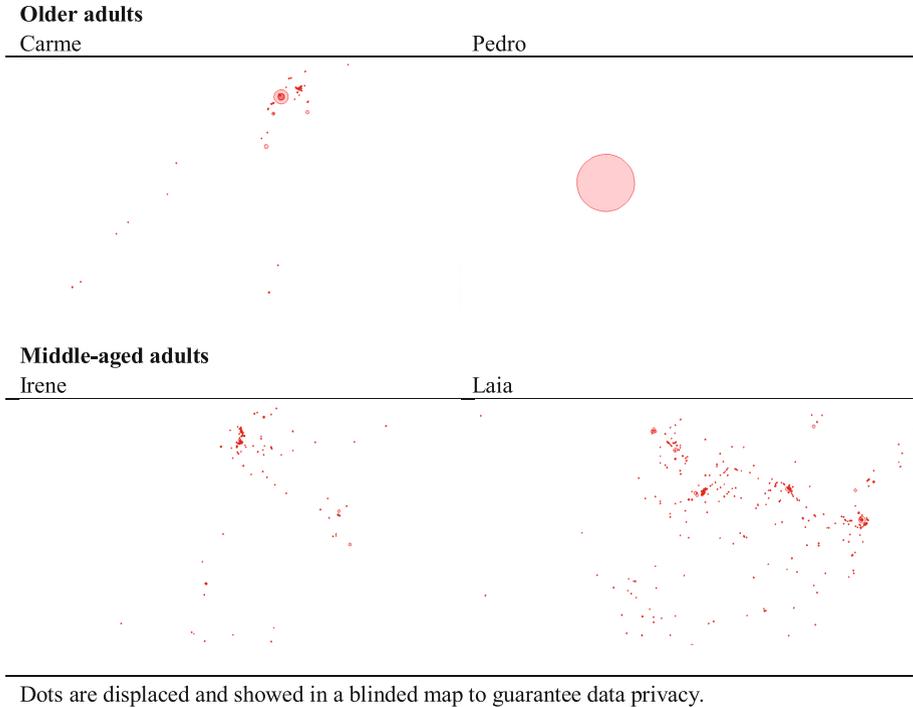
Older adults

Middle-aged adults

Fig. 2. Hourly distribution of smartwatch activities (average values per hour, 3 months)

that the high daytime peaks were due to the fact that she took her watch on and off during the day because of ergonomic and family issues. Of particular interest are ergonomic matters relating to the size and weight of the smartwatch, which causes discomfort when typing on the computer.

Laia used to take off the watch at dinner time – around 9 or 10 pm. Because of this and the fact that she would turn it off before going to sleep, she expected to have a low level of reported activity at night. In this regard, she considered the figure to be good reflection of the way she uses the watch. However, she expected higher numbers during office hours, as she was under the impression that she used to "touch it a lot" while at work. But it was in the evening that there was a spike in activity, which could have been related to incoming notifications regarding social and family life. Finally, the lower levels of activity on her smartwatch are in line with the results obtained in Fig. 1.

4.3   Smartwatch Geo-Located Activities

The logs include the geolocation of each smartwatch activity, but only when the GPS is activated. The maps in Fig. 3 show the geolocated activities tracked on the four smartwatches in the city of Barcelona. Other locations are excluded in this paper to guarantee greater privacy. Non-geolocated activities are not represented, nor are the days of non-use during the three months of observation. Therefore, it is not possible to compare the number and distribution of smartwatch activities among partakers.

Older adults

Carme   Pedro

Middle-aged adults

Irene   Laia

Dots are displaced and showed in a blinded map to guarantee data privacy.

Fig. 3. Geolocated smartwatch activities in the city of Barcelona (3 months)

   Carme usually has the GPS activated, resulting in most of her smartwatch activities being geolocated. She admits that the map gives an account of the usual places she frequents in her life, as well as an account of other locations less frequently visited. Although not shown here, her map included sites in the same province – usually due to weekend activities – and more distant locations – usually trips to visit acquaintances or for vacation. On vacation she ended up taking off the smartwatch. Therefore, these activities are underrepresented on the map. Also, despite the fact she was already aware that we had access to such information, she was impressed with the maps and emphasized how sensitive the log data were: "We [participants] are under your control".

   Conversely, **Pedro**'s map shows he did not have the GPS activated on a regular basis. Although he always wore the watch, there was almost no geolocated information in the watch logs. In fact, he had the watch disconnected – or unpaired – from the smartphone very often (data not shown here).[2] Also, instead of using the Wi-Fi connection, he and his spouse tended to use exclusively the mobile Internet connection for their mobile devices. This is particularly true for the smartphone they have paired with the smartwatch and shows that Pedro and his wife have control over the services they use in their everyday life. That is, they decided to switch off the GPS and Wi-Fi most of the time, switching it on only in specific situations. This resulted in a map with a decidedly

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[2] This did not affect the ability to gather log data.

different – and inaccurate – image of the use of the smartwatch compared to previous information.

Irene identified herself with most of the geolocated activities shown on the map. It gives an account of the places she most frequents in her everyday life. However, the maps also led her to remember that she did not have the geolocation option activated that often, so it would be somewhat difficult to identify her less usual places.

Finally, **Laia** was amazed by the map. She used to switch on the GPS when wearing the smartwatch, which is why she thought she had so many points on the map. The map reflects her activity during the period, but this is not her average, regular activity. For example, she travelled less and conducted more activities in Barcelona than usual, resulting in more geolocated activities in the city. She was able to recognize her regular activities by identifying frequently visited places, and specific irregular activities in places she visited a limited number of times during the period. She found the map particularly useful for building everyday life memories.

4.4   An Essential Device?

To evaluate the importance of the smartwatch, we asked participants if they would keep using the device once their commitment with the project came to an end.

Carme explained that the smartwatch was practical. It had become an everyday life object, but not essential to her, mainly because the smartphone functions were duplicated on the watch. This idea appeared in different interviews, showing that her assessment of the new device did not change during the months she wore it.

> Carme_i2: *Well, I look less at the phone… because I have notifications here [on the smartwatch]. Not much more. … Look, I think the smartphone is useful for everything. And the watch, well, it's wonderful. … It's beautiful. It's cute. … You show it to anyone "Wow, what a watch you wear, how cutting-edge you are!" … But not much more.*
> Carme_i5: *It's more like a hobby. For somebody it could be useful, for me, too. For me, a regular watch is ok. You can follow the steps here [on the phone]; you can see the pictures, the bus information, the maps [on the phone]. Sometimes, it's a duplicate. In some moments it's ok to have it [this information] on the wrist.*

After some experience with it, in the third interview she explained she would not buy a smartwatch on her own. Although she was a happy user of the watch, in the last interview she explained her future plans for the device:

> Carme_i5: *When the project is over, I think I'll give the watch to my nephew, for his birthday. I'll give this to him and it will be the coolest thing ever.*

Pedro, on the contrary, said he would keep using the smartwatch after the project. Rosa confirmed this, indicating that he was a fan of the device. As he explained at different times, for him "the steps (counter)" was extremely useful. The usability of the smartwatch was also key, as he preferred wearing it over having the smartphone in his pocked when he went on his morning walks. He has stopped using the smartphone's pedometer and only checks the information on the smartwatch. Therefore, when asked in the fifth interview, he explained that he "would consider buying a new one" if the smartwatch got broken.

According to **Irene**, the watch was a useful device, mainly for social purposes, particularly so that her personal network could reach her. Without the watch, she would have missed most of her phone calls and would not have received messages on time. She thought that she would keep using the watch after the project. However, wearing it all the time was uncomfortable; the watch was too big and heavy for her. Two particularly uncomfortable situations were wearing it while typing on the computer and wearing it with winter jackets, which tend to have tight-fitting sleeves for the dimensions of the smartwatch, during outdoor activities.

When she decided to put it on, **Laia** got accustomed to wearing the watch the entire day. She agreed that it was uncomfortable to wear while typing, but she found ways to get around this. She encountered a number of trade-offs with the smartwatch. For instance, when checking the time, she liked the big numbers and appreciated having the "official local time" provided through the mobile operator network. However, she found the need to touch the black screen each time she wanted to look at the time useless. She therefore tried to familiarize herself with the wrist movement feature to turn the screen on, but she never mastered it. She finally decided to keep the screen black as much as possible, as, in some contexts, the smartwatch could show unwanted information – a very prevalent concern when wearing short sleeves. These trade-offs, coupled with the battery issues, led to a feeling of relief when she had to (temporarily) lend the smartwatch to another partaker due to technical issues.

In summary, personal interests define digital activity no matter the age of the user. We found that in some instances new digital devices can foster the achievement of these interests, while in others they have no effect at all. The smartwatch is incorporated when it proves useful, particularly in comparison to the screen against which it competes: that of the smartphone. For the participants in the study, tracked data created a new way of depicting daily activities.

5   Conclusion

Smartwatches still have significant market possibilities, even though they might need to undergo a redesigning to meet users' needs better. At present, potential users are already highly accustomed to wearing a wristwatch and the concept of gathering information from it, such as the date or time. Moreover, watches are fashion accessories, often worn to express personal style [15]. For the analyzed participants, older and middle-aged adults, it was quite easy to integrate an augmented watch into their everyday lives. It allowed for more natural interaction [34] and provided them with a wearable extra screen that complemented the smartphone. However, a key point for becoming a long-term user was the cost-benefit balance, or the trade-offs, that accompanied the device. In this sense, participants evaluated the smartwatch's usability mainly in comparison with that of the smartphone – e.g. in situations in which the user could have also kept the phone in their pocket to complete a given task. Another important dimension, the new services only available on the smartwatch and not on other devices, such as the heartbeat monitor, appeared less prominently in this study.

To obtain better insight into the processes behind the adoption of this new digital device, we applied a mixed-method approach that combined log data and interviews during a one-year fieldwork case study and focused on four users, two older adults and two middle-aged adults. The smartwatch, a multipurpose digital device, served as the entry point through which to explore two main research questions.

- RQ1. How do personal interests shape, and how are they shaped by, first-time use of a smartwatch?

On the one hand, we observed that personal interests might lead to stop using the device. Carme, Irene, and Laia all appreciated easy access to notifications to ensure their connectivity; it was a feature that matched their interests. However, only Irene said she would keep using a smartwatch "if it were lighter." Carme planned to give the smartphone to a nephew once the project is over, and Laia felt relieved when she had to pass the watch on to another project partaker. Pedro adapted the use of the smartwatch to his personal interests, as he loved the pedometer. Moreover, he appreciated being able to look at it all the time. Pedro's use of the smartwatch also made sense when unpaired with the phone, and he plans to keep using the device after the project. To our understanding, Pedro is the participant who had the best experience with the device, as he found a specific feature – the pedometer – that substituted the smartphone.

On the other hand, one case illustrates the way in which the introduction of the smartwatch shaped personal interest – even though this did not necessarily equate to the adoption of the smartwatch in the long term. Laia had never shown an interest in using her smartphone's pedometer, but she started to use the smartwatch's, since it was one the apps these wearables promote the most. She got encouragement from regular push messages. As a result, she got used to the pedometer and kept using it even when not wearing the smartwatch, since the app was also available on her smartphone.

- RQ2. To what extent do tracked data help in interpreting the relationship between the user and the device?

Tracked data provided significant insights into the relationship participants had with the smartphone. We were able to confirm the levels of use of the device: Pedro wore it every day, while the rest of the participants did not. Participants found that the figures we compiled reflected their use of the device in terms of number of daily activities and average activities broken down by hour. The geolocated map was also a fairly accurate representation of Laia's and, to some extent, Carme's and Irene's activities. However, Pedro's geolocated activity delivered biased information due to the way he uses his smartphone, namely with the GPS usually switched off. Based solely on the map, we could infer extremely motionless use, attributing this to technical problems or, following a stereotype – as the user is an old person – to the person being in a situation of dependency that prevents them from leaving the home. Applying the mixed-method approach allows us to establish a very different picture: an old person who uses the smartwatch mostly as a pedometer to track his high levels of daily walking activity, but for which geolocated data is not able to provide good quality information due to the device settings defined by the user.

In closing, smartwatch uses and forms of appropriation are as diverse as the four participants in our study. Ways of adoption are shaped by personal circumstances and interests, and tracked data help illustrate those uses – at least to some extent. Of particular importance is that the older users, Carme and Pedro, showed higher levels of smartwatch activity than the middle-aged ones. Furthermore, one of the older adults will most certainly keep using the smartwatch and one of the middle-aged adults might keep using it.

6   Limitations and Implications for Future Research

The small size of the case study magnified the limitations of tracked data, an issue that must always be taken into account, regardless of sample size. These limitations pose a greater problem than the lack of generalizable results common to qualitative case studies, as the quality of the tracked data depends on a number of factors that may go undetected. For instance, without the qualitative approach, we would not have been able to understand the motivations of the lack of movement in Pedro's data, since we would not have discovered that he hardly activated the geolocation option. Other limitations involved the technological affordances of the tracking process, as the system only provided information about the watch's activities. That is, we were only able to find out when the screen turned on, but it was impossible to determine whether this activity was generated by the user or by an incoming notification. In the first case, the interaction with the device would be expected to be intentional, something not applicable in the second case. Without specific information on how the activity was generated, we as researchers lose part of the (expected) richness of the data. These two examples show that log data – the raw material for big data approaches – face limitations that must be taken into account, as data affected by non-explicit biases result in badly informed decisions.

In response to this challenge, in a future paper we plan to develop an analysis of the biases gathered log data face and how they impact on both the interpretation of the available variables and the results. Our understanding is that, as proven in other fields, by understanding the limits of the method we will contribute to strengthening it.

References

1. Schirra, S., Bentley, F.R.: "It's kind of like an extra screen for my phone" understanding everyday uses of consumer smart watches. In: Extended Abstracts of the SIGCHI International Conference on Human Factors in Computer Systems – CHI 2015 EA, pp. 2151–2156 (2015). doi:10.1145/2702613.2732931
2. Cecchinato, M.E., Cox, A.L., Bird, J.: Smartwatches: the good, the bad and the ugly? In: Extended Abstracts of the SIGCHI International Conference on Human Factors in Computing Systems - EA CHI 2015, pp. 2133–2138 (2015). doi:10.1145/2702613.2732837

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3. Pizza, S., Brown, B., McMillan, D., Lampinen, A.: Smartwatch in vivo. In: Proceedings of the SIGCHI International Conference on Human Factors in Computer Systems – CHI 2016 (2016) doi:10.1145/2858036.2858522

4. Giang, W.C.W., Shanti, I., Chen, H.-Y.W., Zhou, A., Donmez, B.: Smartwatches vs. smartphones: a preliminary report of driver behavior and perceived risk while responding to notifications. In: Proceedings of the International Conference on Automotive User Interfaces and Interactive Vehicular Applications, pp. 154–161 (2015). doi:10.1145/2799250.2799282

5. Castells, M., Fernández-Ardèvol, M., LinchuanQiu, J., Sey, A.: Mobile Communication and Society: A Global Perspective. The MIT Press, Cambridge (2006)

6. Helsper, E.J., Reisdorf, B.C.: The emergence of a "digital underclass" in Great Britain and Sweden: changing reasons for digital exclusion, pp. 1–18. New Media & Society (2016). doi: 10.1177/1461444816634676

7. Melorose, J., Perroy, R., Careas, S.: World Population Prospects (2015). doi:10.1017/ CBO9781107415324.004

8. Neugarten, B.L.: The young-old and the age-irrelevant society. In: Neugarten, B.L. and Neugarten, D.A. (eds.) The Meanings of Age: Selected Papers of Bernice L. Neugarten, pp. 47–55. The University of Chicago Press, Chicago (1996)

9. Stone, M.E., Lin, J., Dannefer, D., Kelley-Moore, J.A.: The continued eclipse of heterogeneity in gerontological research. J. Gerontol. Ser. B Psychol. Sci. Soc. Sci. **72**, 162–167 (2016). doi:10.1093/geronb/gbv068

10. Rosales, A., Fernández-Ardèvol, M.: Smartphones, apps and older people's interests: from a generational perspective. In: Proceedings of the International Conference on Human Computer Interaction with Mobile Devices and Services – MobileHCI 2016. doi: 10.1145/2935334.2935363

11. Rosales, A., Fernández-Ardèvol, M.: Generational comparison of simultaneous internet activities using smartphones and computers. In: Proceedings of the Conference on Human Aspects of IT for the Aged Population – HCII 2016 (2016). doi:10.1007/978-3-319-39943-0_46

12. Loos, E.F.: Generational use of new media and the (ir)revelance of age. In: Colombo, F., Fortunati, L. (eds.) Broadband Society and Generational Changes, pp. 259–273. Peter Lang, Berlin (2011)

13. Mann, S.: Wearable computing: a first step toward personal imaging. Computer **30**, 25–32 (1997). doi:10.1109/2.566147

14. Martin, T.L.: Time and time again: parallels in the development of the watch and the wearable computer. In: Proceedings of the International Symposium on Wearable Computers, ISWC 2002, pp. 5–11 (2002)

15. Lyons, K.: What can a dumb watch teach a smartwatch? In: Proceedings of the ACM International Symposium on Wearable Computers - ISWC 2015, pp. 3–10 (2015). doi: 10.1145/2802083.2802084

16. Ashbrook, D.L., Clawson, J.R., Lyons, K., Starner, T.E., Patel, N.: Quickdraw: the impact of mobility and on-body placement on device access time. In: Proceedings of the SIGCHI International Conference on Human Factors in Computing Systems – CHI 2008, pp. 219–222 (2008). doi:10.1145/1357054.1357092

17. Ashbrook, D.L., Lyons, K., Starner, T.: An investigation into round touchscreen wristwatch interaction. In: Proceedings of the International Conference on Human Computer Interaction with Mobile Devices and Services – MobileHCI 2008, p. 311 (2008). doi: 10.1145/1409240.1409276

18. Xu, C., Lyons, K.: Shimmering smartwatches: exploring the smartwatch design space. In: Proceedings of the International Conference on Tangible, Embedded, and Embodied Interaction - TEI 2015, pp. 69–76 (2015). doi:10.1145/2677199.2680599

19. Oakley, I., Lee, D., Islam, R.: Beats: tapping gestures for smart watches. In: Proceedings of the SIGCHI International Conference on Human Factors in Computer Systems – CHI 2015, pp. 1237–1246 (2015)

20. Chen, X. A., Grossman, T., Wigdor, D.J., Fitzmaurice, G.: Duet: exploring joint interactions on a smart phone and a smart watch. In: Proceedings of the SIGCHI International Conference on Human Factors in Computing Systems - CHI 2014, pp. 159–168 (2014). doi:10.1145/2556288.2556955

21. Lee, S. C., Starner, T.: BuzzWear. In: Proceedings of the SIGCHI International Conference on Human Factors in Computing Systems – CHI 2010, p. 433 (2010). doi:10.1145/1753326.1753392

22. Müller, F., Günther, S., Dezfuli, N., Khalilbeigi, M., Mühlhäuser, M.: ProxiWatch: Enhancing smartwatch interaction through proximity-based hand input. In: Proceedings of the SIGCHI International Conference on Human Factors in Computer Systems – CHI 2016, pp. 2617–2624 (2016)

23. Oney, S., Harrison, Ogan, A., Wiese, J.: ZoomBoard: a diminutive qwerty soft keyboard using iterative zooming for ultra-small devices. In: Proceedings of the SIGCHI International Conference on Human Factors in Computer Systems – CHI 2013, pp. 2799–2802 (2013)

24. Dunlop, M.D., Komninos, A., Durga, N.: Towards high quality text entry on smartwatches. In: Extended Abstracts of the SIGHCI Conference on Human factors in Computing Systems - EA CHI 2014, pp. 2365–2370 (2014). doi:10.1145/2559206.2581319

25. Nebeling, M., To, A., Guo, A., Freitas, A.A. De, Teevan, J., Dow, S.P., Bigham, J.P.: WearWrite: crowd-assisted writing from smartwatches. In: Proceedings of the SIGCHI International Conference on Human Factors in Computer Systems – CHI 2016 (2016)

26. Lee, J., Cho, D., Song, S., Kim, S., Im, E., Kim, J.: Mobile system design for scratch recognition. In: Extended Abstracts of the SIGCHI Conference on Human Factors in Computing Systems - EA CHI 2015, vol. 2, pp. 1567–1572 (2015). doi:10.1145/2702613.2732820

27. Ehrler, F., Lovis, C.: Supporting elderly homecare with smartwatches: advantages and drawbacks. Stud. Health Technol. Inform. **205**, 667–671 (2014). doi:10.3233/978-1-61499-432-9-667

28. Casilari, E., Oviedo-Jiménez, M.A.: Automatic fall detection system based on the combined use of a smartphone and a smartwatch. PLoS ONE **10**, 1–11 (2015). doi:10.1371/journal.pone.0140929

29. Anderson, L.: Analytic Autoethnography. J. Contemp. Ethnography **35**, 373–395 (2006). doi:10.1177/0891241605280449

30. Creswell, J.W.: Research design: qualitative, quantitative, and mixed method approaches. SAGE Publications, Thousand Oaks (2003)

31. Maxwell, J.A.: Qualitative Research Design: An Interactive Approach. SAGE, Thousand Oaks (2005)

32. UOC: Wear Monitor. https://play.google.com/store/apps/details?id=edu.uoc.mobtech.monitor.monitor&hl=en

33. Braun, V., Clarke, V.: Using thematic analysis in psychology. Qual. Res. Psychol. **3**, 77–101 (2006). doi:10.1191/1478088706qp063oa

34. Rosales, A., Sayago, S., Blat, J.: Beeping socks and chirping arm bands: wearables that foster free play. IEEE Comput. **48**, 41–48 (2015). doi:10.1109/MC.2015.168

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