5-2016

Factors Influencing Long-Term Adoption of Wearable Activity Trackers

Alessandra Regina David Brandao
ard6573@rit.edu

Factors Influencing Long-Term Adoption of Wearable Activity Trackers

by

Alessandra Regina David Brandao

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Human-Computer Interaction

Rochester Institute of Technology

B. Thomas Golisano College
of
Computing and Information Sciences

Department of Information Sciences and Technologies

May, 2016

Rochester Institute of Technology

B. Thomas Golisano College of Computing and Information Sciences

Master of Science in Human Computer Interaction

Thesis Approval Form

Student Name: Alessandra R. David Brandao

Thesis Title: Factors Influencing Long-Term Adoption of Wearable Activity Trackers

Thesis Committee

Name	Signature	Date

Dr. Vicki Hanson _____
Chair

Dr. Matt Huenerfauth _____
Committee member

Dr. Hugo Nicolau _____
Committee member

Abstract

Wearable technology for activity tracking has been widely adopted to support users in improving or maintaining their physical activity rates. However, while some users derive value from their trackers for a long time, others find barriers to incorporating this technology into their routines. Using an online survey focused on both ex-users and current users of activity trackers, this study investigated factors of discouragement and reasons that could contribute to long-term adoption. Subsequent interviews with a sample of ten participants were conducted to complement the understanding of the users' experiences and their motivations. Through these approaches, the findings of this study suggest that long-term use is derived from the positive difference between the sense of usefulness and the effort necessary to maintain the continuous use of the devices.

Acknowledgments

I wish to express my sincere gratitude to Dr. Vicki Hanson, committee chair, Distinguished Professor, for guidance and for all the opportunities to introduce me in the research field.

I also thank Dr. Hugo Nicolau, committee member, for orientation and openness to share, and for being my inspiration to work on research.

My sincere gratitude to Dr. Matt Huenerfauth, committee member, Associate Professor, for all detailed comments and time dedicated to support me during my graduate program.

I also thank Jill Pearson, Graduate Academic Advisor, for all support during my stay in this institution.

And finally, I would like to thank CAPES/CNPq for funding my master program under the Brazilian Scientific Mobility Program (Ciencia sem Fronteiras), process number 88888.076031/2013-00.

Table of Contents

List of Figures

List of Tables

1 Introduction

According to the World Health Organization, in 2014 over 1.9 billion people worldwide above 18 years old were overweight, due to increased intake of energy-dense foods and sedentary lifestyle, which can imply in cardiovascular, diabetes, and other important diseases (Obesity and Overweight n.d.). This problem is intrinsically related to acquired habits throughout life that may be challenging to change due to the need of self-awareness and healthier attitudes which can be difficult to sustain.

Wearable activity trackers (WAT) are a relatively recent technology widely adopted to collect and display quantitative information related to users' physical activity levels, which can be promising to encourage healthier behaviors. However, 1 out of 3 American who owned a WAT stopped using their devices within 6 months (Ledger and McCaffrey, 2014).

Previous studies have investigated critical factors that either would prevent or support users' engagement (Fausset et al. 2013, Shih 2015, Fritz, et al. 2014, Mackinlay 2013, Lazar, et al. 2015). For instance, to reveal challenges in adoption, Shih et al. assigned pre-defined models for their participants for free use within 1.5 months, and found that concerns about accuracy, aesthetics, and lack of waterproofness was related to 65% of the dropouts that occurred by the second week of use (Shih, 2015). While these authors assigned devices for their participants, Fritz et al. (2014) were interested in those who were using their own devices for at least 3 months. They found that some users adapt themselves to the output of the data by self-regulating their routines to the amount of activity they found needed to reach their physical goals.

However, previous studies have been limited to relatively small participant samples and little research has analyzed abandonment or long term adoption considering the user experience from those who voluntarily acquired their activity trackers, as per their own will. This

willingness to achieve a certain target affects the individual interest to persist in self-monitoring that is needed to guide an individual to the desired new behavior (Klasnja, Consolvo and Pratt, 2011).

Therefore, the goal of this thesis was to get data from a large number of WAT users about their abandonment or adoption. An online survey was used to reach a large number of participants. To provide a deeper understanding of users' experience, follow-up interviews were conducted with ten survey participants. By doing so, we aimed to address the following research questions:

RQ1: Which factors might discourage users of wearable activity trackers from continuing to use their devices?

RQ2: How do these users' level of motivation change over time?

Due to recruiting constraints, we noticed a very limited participation of ex-users, which limited the scope to answer RQ1. However, the interviews provided insights into what could contribute to the abandonment of users' devices, by corroborating or adding to previous studies findings. Moreover, as many of the survey participants declared high levels of motivation and had been using their devices for one year or more, a new question arose:

RQ3: Which factors might support users in incorporating an activity tracker in their daily routines in the long-term?

With the advent of the third research question, a follow-up survey was sent to the 266 participants in the original sample. A sample of 10 participants were then invited to attend individual interviews, independently of their answers on the second survey. These interviews explored users' primary expectations, objectives, how they chose their models and usability

issues they encountered. For the long term users, we asked how they incorporated their devices in their daily lives; for the ex-users we asked about what prevented them to keep using.

The results showed that the wearable activity trackers are overall enjoyable for both current users and ex-users. The latter abandoned their devices for usability issues, loss or breakage, or even perceived lack of usefulness after a desired behavior was achieved. Some ex-users, however, had resumed the use of their trackers by the time of the interview. Regarding long term-users, their main reason to keep using their activity trackers can be summarized as an effortless accountability of their activity levels. This required a minimum effort to maintain the devices, with immediate feedback and easy understanding of the data.

The contributions of this study include findings that corroborate some previous works' results and specific suggestions for future design to ease users' effort on dealing with their wearables or to collaborate to users' achievements.

2 Related Work

Several studies have looked at the wearable activity trackers domain under different perspectives. While some introduced a new product and the results of a correspondent evaluation (Apostolopoulos, Coming and Folmer 2015, Consolvo, et al. 2008), others were interested in accuracy of available products (El-Amrawy and Nounou, 2015). This section focuses on those studies that assessed the users' experience with WATs, in which difficulties and successes of dealing with the devices were discussed.

2.1 Lack of Interest in Continuing Using Activity Trackers

Fausset et al. (2013) assigned three different models of wearable activity trackers and one web application to eight participants aged 61-69 for two weeks of use. Despite the fact that this target population was very specific, the results corroborate other studies' reports on levels of abandonment: 5 out of 8 participants declared they would not continue using the models assigned to them due to doubts about accuracy, while others would continue and were motivated with their experience. The authors conclude that conveying usefulness is key to any activity tracker devices to benefit older adults on engaging in their physical activity.

Shih et al. (2015) tested 26 participants, age 20-24, who were assigned to freely use a Fitbit Force (wrist-based) or a Fitbit Ultra (clip-based) for six weeks. They found that 65% of who abandoned their Fitbit did so by the second week of use. Reasons for abandonment included concerns about using the trackers close to water, limited use due aesthetics that would not fit particular occasions, doubts about accuracy, difficulties in remembering to wear the device, and participants' willingness to compare their activity results to the average of the population with similar characteristics of age, height and weight.

Despite the differences in age and number of participants considered by Fausset et al. (2013) and Shih et al. (2015) studies, abandonment rates were above 60% after two weeks of use for both. In considering these results, it is important to keep in mind that both studies assigned specific devices for each participant. Thus, the device tested might not necessarily be the participants' choices if they had acquired their own trackers.

2.2 Sense of Usefulness

In contrast, Lazar et. al. (2015) offered their 17 participants up to $1,000 to purchase devices that thought would best help them achieve their personal goals. The authors did not explicitly mention if their participants were actually aiming to get an activity tracker prior the recruiting. Surprisingly, the study found that the devices purchased often did not appear to map to participants' goals. Moreover, despite the offer of up to $1,000, most participants did not acquire more than one model; they indicated that maintaining more than one tracker would be time-consuming. Authors also noted that some brands/models were chosen in common once participants were likely to be influenced by the choices of other participants they knew in the study. After two months, 80% had abandoned their devices. Users reported an inappropriateness for the needs, that the data collected was useless, and that the effort to keep the devices (primarily battery charging) was not worth keeping using. Also, some participants had chosen models whose specifications would not meet their objectives. On the other hand, the participants who kept using their devices throughout the two months of the study had developed routines, found the devices useful, and found a potential benefit to themselves.

Unlike the Lazar et al. (2015) in which researchers recruited participants used trackers freely for two months, Fritz et al. (2014) were interested in users who had used their own devices for at least three months. Their goal was to investigate the long-term use of activity trackers "in

the wild", focusing on 30 users who had incorporated these devices into their daily routines. Results indicated that participants overall were excited about their devices and enjoyed sharing their data with others. Nonetheless, their initial motivation not necessarily was high as after three months as at the beginning of use. At the same time, some participants mentioned that their mood was profoundly impacted when they occasionally forgot to wear their devices. Some participants also reported that they used to give less attention to their data than they did when they started using their devices. Finally, the authors concluded that some long-term users adapted themselves to the readings of the data by self-regulating their routine to the amount of activity they found needed to achieving their goals.

2.2.1 Intrinsic vs. Extrinsic Motivations

According to Ryan and Deci (1985), extrinsic motivation is given by external factors such as rewards or punishments that drive an individual to execute a task in the direction of a certain objective, whereas the intrinsic motivation incites the action by the inner fulfillment of the task itself. Considering this, it may be possible that Lazar et. al.'s (2015) participants were initially moved by extrinsic motivations since they contributed to the study by a promise of compensation to execute a task they were given. In contrast, overall Fritz et. al.'s (2014) participants could be said as moved by intrinsic motivations, since they seemed to be self-stimulated on using their devices. Neither of these studies, however, considered intrinsic vs extrinsic motivation. This present work considered intrinsic motivation as a potential factor of increasing overall adoption of an activity tracker over time.

2.3 Barriers for Engagement among Users and Ex-users

Harrison et al. (2015) recruited 24 participants, ages 18-55 to investigate barriers to users' engagement. Of these, 16 were current users and eight were ex-users of activity trackers. The time of use ranged from two weeks to three years. Of relevance here is the fact that, 15 out 24 participants did not buy their devices; eight received them as a gift, six through their work and one has acquired from a previous study. Eleven participants reported a temporary abandonment due to loss (6) or stopping working (4) as main reasons. The authors found the following barriers to engagement: battery life, accuracy, lack of social functionalities, lack of customization of features for tracking data, improvements needed in aesthetics and physical form of the devices to englobe the variety of different users' preferences. Since 62% of Harrison et al.'s participants did not buy their trackers and 46% had stopped using their devices, in the present research we were interested in examining the influence of means of acquisition, hypothesizing that devices received as a gift would decrease motivation and increase abandonment over time.

MacKinlay (2013) conducted a usability study interviewing seven participants to gather their experiences when dealing with the Fitbit One, which is a clip-based model. These participants were recruited based on their level of experience on this particular model: no experience, novice experience and experts. Based on findings from interviews, the author discussed four phases users would pass through when dealing with this Fitbit model: i) Introduction; ii) Trial, iii) Personal calibration, and iv) Satisficing. The author states that after a few weeks, users tended to lose their infatuation with their device and have significant doubts about its accuracy. MacKinlay concluded that the lack of visibility of system status, and its low-ceiling learning curve affected engagement.

2.4 Summary

Based on the literature reviewed, we sought to investigate whether users' initial goals related to their devices capabilities, as a factor that potentially discouraged users on adopting their activity trackers. This understanding supported this study's first research question: RQ1: *Which factors might discourage users of wearable activity trackers from continuing to use their devices?*

In addition, we aimed to understand issues of motivation (intrinsic vs. extrinsic) and forms of acquisition as factors that would contribute to decreased levels of motivation over time, in order to answer the RQ2: *How do these users' level of motivation change over time?*

Moreover, since few studies focused on participants' choices to acquiring their activity trackers, and also little research looked at long-term adoption, we intended to answer the third research question: RQ3 - *Which factors might support users in incorporating an activity tracker in their daily routines in the long-term?*

3 Methodology

3.1 Study Design

In order to answer this study's research questions, an online survey with open and closed-ended questions and the follow-up interviews were developed and submitted to the Institutional Review Board (IRB) for approval. When this approval was received, the survey was posted online and hosted by SurveyMonkey.com from March 1st to April 2nd, 2016. Our goal was to collect a balance of participants who were current users and those who abandoned their devices.

The majority of the survey's questions were closed-ended (see Appendix A), which eliminated the need for coding responses and facilitated the process of data analysis. Most questions were directly related to answering the research questions RQ1 and RQ2; a few were demographic in nature or supported the understanding of the data collected from answers to the closed-ended questions. To address the RQ3, a second survey was needed, as explained later.

Ten follow-up semi-structured interviews were conducted through Skype, Google Hangouts, telephone call or in person with a sample of participants randomly selected among the survey respondents who declared their willingness to attend an individual interview session. Overall, these interviews were intended to provide a deeper understand participants' experiences with their trackers, to identify potential factors that would influence users to abandon their devices, as well as what would contribute to a long-term adoption of wearable trackers in participants' daily lives. It was intended that half of the interviews would be conducted with current users and the other half with those subjects who had stopped using their trackers. However, due to a limited number of participants in the ex-users group, only four interviews could be conducted. This increased the number of interviews with the current users group from five to six.

The interview sessions took up to 30 minutes and were audio recorded for further transcription and subsequent coding with a general inductive approach. This method provided a straightforward and uncomplicated process for deriving findings from textual data. This procedure consists of identifying the most important themes in three steps: i) summarizing the textual data, by segmenting and labeling these segments to create categories; ii) establishing the associations between these summary findings and the research goals; and iii) developing a framework of the experiences that raised from the data (Thomas, 2006).

3.1.1 Complementary Survey

About one week after the survey became available, a low participation among ex-users was observed. We observed a large participation of current users with high levels of motivation, using their devices for one year or more. This scenario resulted in adjustments to the scope of this study. It delimited the extent of RQ1 and RQ2, and defined a third research question to understand what would contribute to participants' engagement on using their devices for a long term. Hence, a second complementary survey was sent to all participants by email that were current users of wearable activity trackers and who had provided their email addresses with the original survey. Current users group were invited to answer "what makes you use your activity tracker?" (see Appendix B), whereas the ex-users were asked why they stopped using it (see Appendix C).

The Institutional Review Board (IRB) approval for this research was appropriately updated. Once the IRB approved this project scope update, the complementary surveys were published at SurveyMonkey.com as the first one was, and invitations to complement the participation were then sent by email.

3.1.2 Interviews

Once the surveys ended, the follow-up interviews were scheduled with 4 ex-users and 6 current users. Due to lack of replies, a total of 25 current users were randomly selected among those participants who provided any comments on at least one open-ended question, and then invited to attend one of the target 6 interviews actually conducted.

Due geographical constraints and as per participants' convenience, three interviews were done in person; two by telephone calls and five through Skype or Google Hangouts. Two participants lived in Canada, one in the United Kingdom and seven in the United States (North Carolina, New York, Ohio and Pennsylvania).

The set of interview questions were intended to gather information about the factors that may have influenced participants' decisions to stop using or incorporating their wearables in their daily lives. These questions mainly investigated: Users' expectations prior they acquired their trackers, how they chose their models, usability issues, factors that encouraged and discouraged use, frequency of use, changes in daily habits, and how they used to deal with the data shown by their wearables. Regarding abandonment, the ex-users group was specifically asked about reasons why they stopped using their trackers, whereas the current users group was questioned about occasions they stopped using their devices, and if so how this experience was for them. The survey questions were semi-structured, depending on the flow of the interview and the topics mentioned by the participants in their responses. The complete set of the questions that guided the interview can be seen in Appendix D.

3.2 Participants

3.2.1 Eligibility

Any person was eligible to participate in the surveys if they were 18 years or older and had used or were currently using a wearable activity tracker for any period of time. The first two questions in the survey were a screening questionnaire which asked if participants were 18 years old or more and if they were current users or ex-users of any wearable activity trackers. If a given survey participant had never used such device or if their age was under 18 years old, there were shown a thank you message and the was survey terminated.

3.2.2 Goal and Achievement

Since, this study aimed to a minimum of 200 participations, balanced between current users and ex-users, several invitations to participate were posted on social media on Facebook, Twitter, web forums, and Google+. However, among all the 335 eligible respondents, only 17 (5%) were ex-users. In contrast, 318 were current users (95%). This imbalance primarily resulted from the low participation among ex-users in the Facebook communities where we focused our posts, which were related to use of activity trackers of several brands or purposes (see Appendix E). A reason for this low participation of ex-users may be due the fact that ex-users would unlikely be following these communities. In order to overcome this limitation, we considered posting payed advertisements on Facebook that would potentially reach a greater diversity of Facebook users related to activity trackers, independently of their participation in any groups or communities. However, as of March of 2016, the technology “activity trackers” was not available for selection to create an advertisement in Facebook, which prevented us from

following this approach. Due to timeline constraints, no other alternative was considered to get participation of more ex-users.

Regarding gender, the majority of our participants identified themselves as female (81%), whereas 17% as male and 2% preferred not to disclose. About age, half the participants were above 45 years old, and the other half from 18 to 45. Table 1 details the participants' distribution by gender and age ranges, and adds this representation within subgroups of current-users and ex-users.

Table 1. Age and gender representativeness on total participation and on groups of current users and ex-users

		All participants (N = 335)		Current Users (n = 318)	Ex-users (n = 17)
		Quantity	%		
Gender	Female	271	81%	83%	35%
	Male	58	17%	15%	53%
	Preferred not to disclose	6	2%	1%	12%
Age	45+	166	50%	51%	18%
	36-45	71	21%	22%	6%
	26-35	72	21%	20%	47%
	18-25	26	8%	7%	29%

Regarding the major representativeness of age and gender, the participation in this study is somewhat similar to the users of activity trackers in the United States in 2014, according to the NPD Connected Intelligence Consumers and Wearables Report[1]. While 71% of this study's participants were 36 years old or more, the same age range was represented by 60% of the users in the US. About gender, while 81% identified themselves as women in this study, 54% of the American users were women in 2014.

[1] https://www.npd.com/wps/portal/npd/us/news/press-releases/2015/the-demographic-divide-fitness-trackers-and-smartwatches-attracting-very-different-segments-of-the-market-according-to-the-npd-group/

3.2.3 Compensation

No compensation for the survey was directly provided to the participants; however, two Amazon gift cards of $25 were raffled among those who participated and decided to provide their email addresses to be considered in the raffle. These email addresses were printed and closed on April 14th, 2016, so this study's chair could pick two of them from "a hat". The investigator then sent the gift card code by email to the winners.

Among those who left their email addresses for the follow-up online interview, ten were randomly selected among those who left any comments on at least one open-ended question, and were compensated with an Amazon gift card of $25 for their time in their countries' currencies. This necessity of providing gift cards in different currencies was not observed when this work was initially planned. However, according to the Amazon gift card current policies, a given gift card purchased at a given Amazon website should be redeemed at limited Amazon websites. Therefore, if participants from Canada or the United Kingdom were given amazon.com gift cards, they would not be able to redeem their compensation at amazon.ca or amazon.co.uk. All gift cards codes were sent by email, except one for a participant in the UK, who received theirs by mail and as per their agreement, since there was no e-gift card under £50 available at amazon.co.uk.

3.2.4 Invitation to Participate in the Survey

This study posted invitations on Facebook, Twitter, Google+ and web forums related to activity trackers to obtain participation in the online survey. This research was intended to obtain contributions independent of the different brands and models in use or available in the market. Therefore, 12 brands were combined from three recent studies as a baseline, which were: Basis, Fitbit, Garmin, iHealth, Jawbone, Lifetrak, Misfit, Nike+ Fuelband, Polar, Sony SmartBand,

Striiv and Xiaomi (El-Amrawy and Nounou 2015, Fausset, et al. 2013, Yang, et al. 2015). An additional "Others" open-ended option was offered so participants were able to indicate a different brand. These 12 brand names were then organized in alphabetical order (see Appendix A, question "What is the brand of your device?"). The related models of these brands were collected from these brands' websites to comprise the options that participants would select subsequently. This survey organization would not only facilitate participants' selections of their brands and models but also ease further data analysis process. This list of brands and models was also base to conduct a search on accounts and hashtags on Twitter, and communities on Facebook and Google+ where postings were then made.

Initially, we posted invitations on Twitter and Facebook (see Figures 1, 2), with the exact content as approved by the Institutional Review Board (IRB). These messages comprised a brief message and a short link to the survey with some hashtags to reach as diverse online users an ex-users of activity trackers as possible.

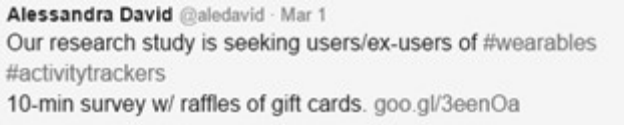


Figure 1. Invitation to participate in the online survey - example of a post in Twitter

Figure 2. Invitation to participate in the online survey - example of a post in Facebook

Several actions and postings were made in the first fortnight of March 2016. The result of these actions and corresponding number of responses gathered at surveymonkey.com can be seen in Figure 3. The bars in this image include not only the total participations reported by this study (N = 335), but also those participants who started answering but did not meet the eligibility criteria, or those who were eligible but did not complete the whole set of questions, and also a double participation.

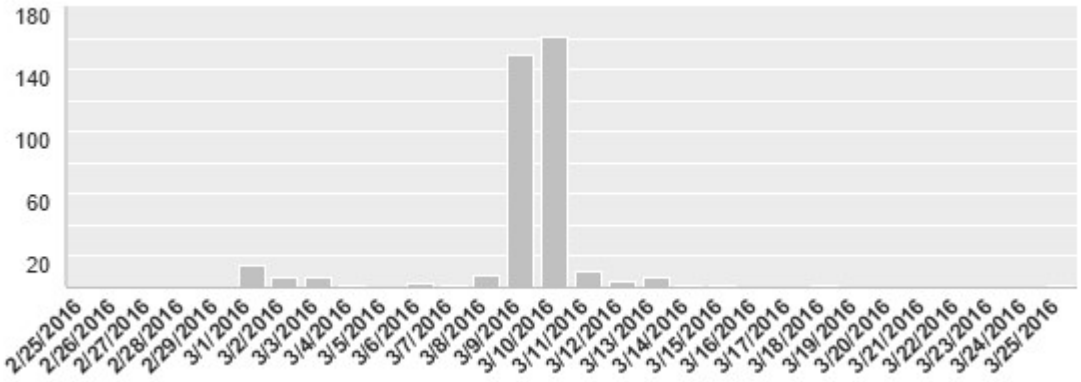


Figure 3 - Graph from surveymonkey.com: number of responses per day

As the previous Figure 3 indicates, the survey was far to reach 20 responses per day since it was published on March 1st, and until March 8th. The main reason for greater participation on

Mar 9th and 10th is attributed to the change of language used in the posts done on Mar 9th, which was personalized for each one of the communities in which the message was posted; thus, the approach used until then was likely understood by the Facebook group administrators as simply advertisements which led to subsequent post deletion. The detailed history of posts in social media, potential reasons for the number of answers each day and all the hashtags and groups considered can be seen in Appendix E.

3.2.5 Criteria to select potential interviewees

These were the following criteria to select participants for the interviews:

- Ex-users: Since there were only 5 participants in this group that left their emails which were exactly the number of interviews expected to be done within this group, the willingness to attend was the single criteria used for selection. Thus, all participants that provided their email were invited. Of these, four replied and attended an interview.
- Current users: Since one of this study goals was to understand what would make people use their devices for a long time, the first filter applied to this group was the time of use as at least 10 months, which was between the 6 months reported by Endeavour Partners in which one-third of users are likely to leave their trackers (Ledger and McCaffrey, 2014), and the 14 months as the mean of use reported by Fritz et al. (2014) study. Also, participants were considered for selection if they left any comments in at least one of the following questions:
    - "What was your primary reason to use your activity tracker? - Other (please specify)"
    - Comments on "Did this device help you to reach your goals?";

- Answers for “What you like the most in your device?”;
- Answers for “What you dislike the most in your device?”;
- Answers for “What makes you use your device?”.

This filter resulted in 150 participants in the current users group to be considered for an interview, from which a total of 25 participants were randomly selected and sent an invitation to attend one of the 6 interviews for this current users group; 19 did not reply. All invitees were given 2 to 5 days to reply to schedule their interviews. This given time was initially 5 days, and since several cycles of invitation were needed, it was reduced to 2 days in order to mitigate risks in the project timeline.

3.2.6 Overview on participants’ characteristics

According to the major representativeness of characteristics among all participation (see Table 2), we our participants were *current users of activity trackers who had been wearing their devices for at least one year. these users decided to purchase their models to better take care of their health*. In addition, 50% of our participants are above 45 years old and 81% identified themselves as women. However, there were differences detailed in Table 2, which shows quantities and percent values for subgroups of age, gender, time of use, primary reasons, forms of acquisition and whether their goals were achieved or not with the support of their devices. In addition, the values under “Distribution related to the subgroup” indicates the representativeness of each subgroup to either group of current users and group of ex-user.

Table 2. Survey participants: distribution in categories and subgroups

		Distribution (N = 335)		Distribution related to the subgroup	
Category	**Subgroup**	**Quantity**	**%**	**Current Users (n = 318)**	**Ex-users (n = 17)**
Gender	Female	271	81%	83%	35%
	Male	58	17%	15%	53%
	Preferred not to disclose	6	2%	1%	12%
Age	45+	166	50%	51%	18%
	36-45	71	21%	22%	6%
	26-35	72	21%	20%	47%
	18-25	26	8%	7%	29%
Current users or ex-users	Current users	318	95%	-	-
	Ex-users	17	5%	-	-
Time of use	One year or more	206	62%	64%	12%
	3-11 months	82	24%	24%	41%
	Less than 3 months	47	14%	12%	47%
Primary reasons	Intrinsic	319	95%	95%	100%
	Extrinsic	15	4%	5%	0%
	Not categorized (*)	1	0%	0%	0%
Goals met?	Yes	290	87%	88%	53%
	No	45	13%	12%	47%
Form of acquisition	Bought	244	73%	73%	76%
	Gift	86	25%	24%	18%
	At work	6	2%	2%	0%
	Built by the participant	1	0%	0%	0%
	Not specified	1	0%	0%	0%

(*) Due to the lack of details available.

Regarding primary reasons, participants' choices on this question were classified in intrinsic or extrinsic motivations on acquiring an activity tracker. Particularly within the ex-users group, no participant had extrinsic motivations.

Answers on goals achieved were selections on "yes" or "no", and 290 participants reported their devices helped them to reach their goals (87%), whereas 45 participants mentioned their devices did not (13%). Among these 45, 8 stopped using their trackers, whereas 33 continued using.

Regarding forms of acquisition, while 244 participants bought their devices (73%), 86 got as a gift (25%), and six from work (2%). Also, one participant built their own tracker and another did not specify how their device was acquired.

3.2.7 Participants' Activity Tracker Models

Despite the fact that this study did not plan to compare the products in use, only whether participants' initial expectations would meet their devices' capabilities, we asked participants to select their model's name and brand.

Some products that were offered as choices in the survey did not have any representation among this study's participants. Specifically, no participants used Lifetrak, Striiv or Xiaomi. On the other hand, Apple Watch, Humana, Intex, and Samsung were indicated by participants in the "Others" field. Since participants had only one option in the survey to choose their devices' brand, and subsequently had also a single option to select the name of their model, some chose "Others" to specifically indicate more than one product they owned. However, four of these participants were unspecific, citing "I have had 4 different kinds", or "like a wristband" (for a Misfit), "Misfit and Fitbit", or just "Fitbit and Apple Watch". Hence, it was not possible to identify which model exactly these participants were writing about.

Table 3 shows the number of participants who cited each product, date of announcement or availability in the market, and approximately how long now these products could possibly be used. If a given participant indicated more than one model and explicitly labeled which models they owned, these were included in 3. Therefore, the sum of quantities of participants in Table 3, which is 337, does not correspond to the exact number of participants in the study (N = 335).

Table 3. List of products used by the survey participants

Brand / model	Quantity of participants	Date of availability	Years now, approximately (as of April 2016)
Apple Watch	3	Apr-15	1
Basis	1	Sep-14	1.5
Fitbit			
Blaze	4	Jan-16	0.5
Charge HR	38	Jan-15	1.5
Charge	28	Nov-14	1.5
Surge	7	Oct-14	1.5
Flex	29	May-13	3.0
One	14	Sep-12	3.5
Zip	4	Sep-12	3.5
Garmin			
Vivosmart	3	Oct-15	0.5
Vivoactive	1	Jan-15	1.5
Vivofit 2	3	Jan-15	1.5
Vivofit	57	Jan-14	2.5
Misfit			
Shine 2	3	Oct-15	0.5
Speedo Shine	5	Aug-15	0.5
Link	1	Jul-15	1
Swarovski Activity Crystal	2	Jan-15	1.5
Flash	3	Sep-14	1.5
Shine	52	Nov-12	3.5
Humana Gear 2	1	Not found	-
iHealth Tracker	1	Not found	-
Intex			
Fitrist	2	Feb-16	0.2

Brand / model	Quantity of participants	Date of availability	Years now, approximately (as of April 2016)
Jawbone			
UP2	19	Apr-15	2.5
UP4	1	Apr-15	1.5
UP3	14	Nov-14	2.5
UP Move	7	Nov-14	2.5
UP24	5	Nov-13	4.5
UP	2	Nov-11	0.5
Nike+ Fuelband	1	Nov-13	2.5
Polar			
Loop Crystal	1	Nov-15	1
A360	1	Oct-15	0.5
A300	1	Feb-15	1
M400	1	Oct-14	1.5
Loop	13	Sep-13	2.5
RC3	1	Aug-12	3.5
Samsung	4	Sep-13	2.5
Sony Smartband 2	1	Mar-15	1
Smartphone App	2	Not specified	-
Built by participant	1	Not specified	-

From Table 3 we can see that the top 5 brands represent 95% of all devices owned by the participants. Fitbit was cited by 124 participants (37%); 67 cited Misfit (20%), 64 Garmin (19%), 48 participants indicated Jawbone (14%), and Polar was cited by 18 (5%). Regarding models, the most cited were: Garmin Vivovit, used by 57 participants (or 17% among all survey participants), Misfit Shine (52 participants or 15%), Fitbit Charge HR (38 participants or 11%), Fitbit Flex (29, or 9%) and Fitbit Charge (24, or 7%). These products are 60% of all those mentioned by the survey participants. The complete set of products for the top 5 brands and the related number of participants using them can be seen in Figure 4.

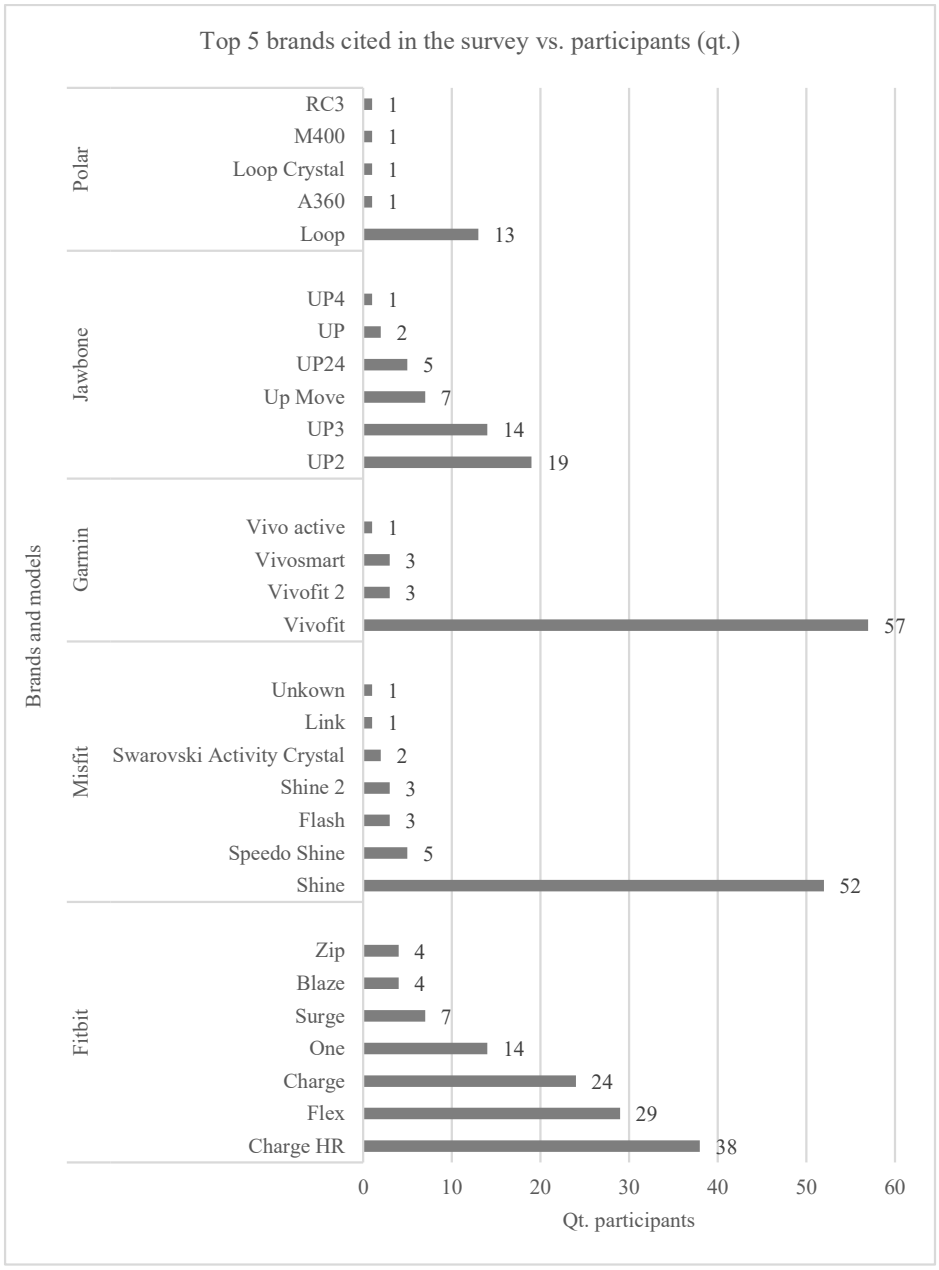


Figure 4. Quantity of participants per model mentioned in the survey, for the top 5 brands cited

3.2.8 Time Using Activity Trackers

Participants reported one week to 10 years of use. To obtain the average and median among all participants' time of use, the information participants provided was converted to months. Among all survey participants, this resulted in a median of 12 months or $M = 17.5$ ($SD = 15.6$). While current users used their devices from 1 week to 10 years (median of 14.3 months, $M = 18.1$, $SD = 15.7$), ex-users used their devices from 3 weeks to 2 years (median of 3 months, $M = 6.8$, $SD = 6.6$, or in weeks: median of 13, $M = 29.6$, $SD = 28.8$).

3.2.9 Time of Use Greater than Related Products Availability in the Market

Some participants reported 10 years of use of an activity tracker. Since 10 years is more than the double of possible time for use of even the oldest product cited by the participants (Jawbone UP 24, 4,5 years), the time reported seemed improbable. Thus, by analyzing the data we identified that 63 participants, or 18% of all survey participants who reported using their devices longer than their products were available in the market; among these, 28 reported this time of use as twice the possible time. One possibility for this discrepancy could be the inaccurate recall about the right time these participants started using their devices. Another reason would be that these users had different models prior the current wearables they actually reported, which could include pedometers or heart monitors. For example, one of the participants wrote in the "Other models" field: "Polar Loop now but previously Polar exercise watches".

Table 4 shows some of these discrepancies, listing all participants in this condition that reported 4 to 10 years of use. The table includes their models, the length of time their products are available in the market, participants' time of use and any comments that were provided. Since this study considers long term as at least ten months of use, and these discrepancies are

regarding years of use, these data that were initially considered as discrepancies were not discarded in the data analysis, and thus are considered as long-term.

Table 4 – Time of use reported above 4 years and inconsistencies with product's availability in the market

Time of use	Participants (qt.)	Age range	Brand-Model	Available for approximately	Participant comments
10 years	1	36-45	Garmin Vivofit	2.5 years	N/A
8 years	1	45+	Jawbone UP3	2.5 years	N/A
7 years	1	45+	Fitbit One	3.5 years	N/A
6 years	1	45+	Fitbit Charge HR	1.5 years	N/A
	1	45+	Misfit Shine	3.5 years	N/A
	1	45+	Polar Loop	2.5 years	"Polar Loop now but previously Polar exercise watches".
5 years	3	45+	Fitbit Charge HR	1.5 years	One participant reported: "have used different trackers over the years, but it motivates me to do so"
	1	45+	Fitbit One	3.5 years	N/A
4 years	2	45+	Fitbit Charge	1.5 years	N/A
	2	36-45	Fitbit Charge HR	1.5 years	N/A
	1	45+	Fitbit Surge	1.5 years	N/A
	1	45+	Misfit Shine	3.5 years	N/A
	1	45+	Polar Loop	2.5 years	N/A

3.3 Interview Procedure

Participants were invited to schedule an appointment, indicating the country and/or state from where they would be talking. The email also suggested Skype or Hangouts as means of communication and explicitly indicated that other ways would be welcome as suggestions. After setting the appointment, participants were sent the Informed Consent by email to save time on the call time. They were not required to send the document signed back due to the IRB exemption (see Appendix F). This Informed Consent was briefly discussed at the beginning of the interview to assure participants acknowledged the document's content. Audio recordings were only started after participants declared their consent. Compensations were sent by email,

except one which was delivered to a participant's mail address in UK with participant's agreement.

3.4 Research Questions vs. Survey Questions

In order to guide the organization of the data collected for the data analysis, the research questions were associated to the survey questions as indicated in Table 5.

Table 5. Relationship between research questions and survey questions

Research Question	Survey question	Objective
RQ1: *Which factors might discourage users of wearable activity trackers from continuing to use their devices*?	*Why did you stop using your device*? (open-ended)	To analyze potential reasons of abandonment.
	What were your goals before starting to use your device? *What is the brand/model of this device*?	These questions would support the investigation of potential inconsistencies between participants' goals and their device capabilities. The participants' models specs were gathered through the products manuals available online (the table of models and specs considered by this study are available in Appendix G.
	How satisfied are you with: Data in device; Data in app/web; Sync; Sharing data; Accuracy; Battery life; Comfort; Aesthetics; Price	To investigate low rates of satisfaction and related usability issues users may find.
RQ2: *How these users' level of motivation may be changed over time?*	*How motivated were you prior to start using it?* *If you are a current user: How motivated are you today to use your device?* *If you are an ex-user, how motivated were you when you stopped using it?*	The first and the last level of motivation, to identify increase, a decrease of unchanged levels of motivation over time between current users and ex-users.
	What was your primary reason to use your activity tracker?	This question was used to categorize the primary reasons as intrinsic or extrinsic motivations, and compare to differences between levels of motivation over time. The hypothesis

Research Question	Survey question	Objective
		was that intrinsic motivation would increase more levels of motivation than the extrinsic would.
	How did you get your activity tracker?	To analyze if the devices that were got as a gift would impact on decreased motivation over time or affect abandonment.
RQ3: *Which factors might support users in incorporating an activity tracker in their daily routines in the long-term*	*What does make you user your activity tracker?* (open-ended)	To analyze potential reasons for long term use and engagement on using an activity tracker.

3.5 Data collection

Due the nature of this study design, both quantitative and qualitative data were collected from the surveys and interviews. Most survey questions were closed-ended; the few open ended supported both the understanding of participants' selections on the survey, as well as answering the research questions.

The survey data was downloaded from SurveyMonkey. This included information from those who did not complete all questions due to either ineligibility or dropouts before the question about the last level of motivation was reached, critical for RQ2. The dataset was then cleaned, by removing three types of data: i) data associated to ineligibility, ii) double participation which was identified by participants' email addresses, and iii) incomplete answers regarding the last level of motivation.

After the data from the complementary survey was collected, a similar process of cleaning was performed. From the 95 answers gathered in the complementary survey, three answers had to be excluded since participants did not answer the question, but cited their models

in use instead. Because participants were required to fill in their email addresses, it was possible to associate their answers to the first survey answers.

For confidentiality of analysis, participant names were coded without their identifying information and the list of their email addresses was kept separated from the data that was examined.

The interview transcripts were coded using a general inductive approach. Data was organized in Excel files to ease the process of segmenting, categorizing and establishing associations between conclusions and the research goals.

3.6 Data Analysis

Descriptive statistics were applied to the demographic data and sets of subgroups: current users and ex-users, primary reasons categorized in extrinsic and intrinsic motivations, initial goals, forms of acquisition and levels of satisfaction with aspects of participants' devices. Levels of satisfaction were gathered from a Likert scale with 1 – *Very unsatisfied* to 5 – *Very satisfied*.

To test whether primary reasons would influence levels of motivation over time, two coders classified participants' answers on their primary reasons as intrinsic or extrinsic motivations, with satisfactory inter-rated reliability (K = .96). As examples, intrinsic motivations were related to choices on "I wanted to better take care of my health" or comments in "Others" that were associated to participants' inner interests for satisfying themselves and not as per external demands of others, such as "I wanted an alarm clock without sound" or "I was keen to see how active I was, and to improve upon it.". Extrinsic motivations were derived from choices on "I had medical reasons", or comments on the "Others" option, such as "Discount from

employer for insurance premiums", or "Our employer requires a way to prove 960-min activity/quarter".

This classification resulted on 319 participants with intrinsic motivations, 15 with extrinsic and 1 that was not associated to either category due to lack of information from one participant's answer. No participant in the ex-user group had extrinsic motivations.

All statistical tests used an alpha value of .05.

Since the datasets were not normally distributed, nonparametric statistics was used to test if intrinsic motivation would influence more levels of motivation over time than the extrinsic group would.

For similar reasons, non-parametric statistics was also applied to test whether devices received as a gift would affect decreased motivations over time, two datasets were set considered: devices that were "bought" or were received as "gift". These datasets contained the differences between last and initial motivations for each participant. Our hypothesis was that devices received as gift would result in decreasing motivations over time and would influence abandonment.

In order to analyze whether participants' initial objectives would be unrealistic with respect to their devices capabilities, participants' initial goals were associated with their products specifications. These specifications were gathered from manuals available on each product's website. The list of specifications derived from the question "What were your goals before starting using your device." For this question, each participant could select as many options as were their goals was: tracking steps, tracking distance, tracking heartbeat, tracking calories burned, tracking sleep, alarm clock and sharing data. After this mapping (see Appendix G), we

used Excel formulas to identify possible gaps between participants' choices and their products' features.

To outline how participants' level of motivation changed over time, the survey participants reported their level of initial motivation when starting using their devices. Responses used a scale as follows: 1 - *Not motivated at all;* 2 - *Neither motivated nor not motivated;* 3 - *Somewhat motivated;* 4 – *Motivated;* 5 - *Very motivated.* Using this scale, current users reported their current level of motivation using their trackers; ex-users reported the level of motivation as they recalled from the time they stopped using their devices. To facilitate the reading of this report, the current level which was reported by current users and the level of motivation at the moment ex-users abandoned their devices will be both referred hereafter as simply "last" motivation reported by the survey participants. In order to analyze if participants' motivations increased over time, non-parametric statistics was run since the datasets were not normally distributed. The interview data was used to complement the data gathered by the survey questions, by describing how some participants' perceived their motivation changed over time.

Survey open-ended questions and transcripts of the interviews were coded for identifying recurrent keywords and themes associated to the research questions.

4 Results

This section reports results of possible reasons that influence abandonment of activity trackers as well as factors that support long-term adoption. In addition, we outline how users' motivation changed over time.

4.1 Participants' Levels of Motivations on Using their Activity Trackers

Medians for initial and last level of motivations are given in Table 6 for all participants, and for groups of current users and ex-users. Differences between these medians are also presented.

Table 6. Participants' initial and last levels of motivations on using their trackers

	Initial level of motivation (*Median*)	**Last level of motivation (*Median)***	**Differences in the *Medians* *(last – initial)***
All participants (N = 335)	3.00	5.00	2.00
Current users (n = 318)	3.00	5.00	2.00
Current users > 1 year (n = 204)	4.00	5.00	1.00
Ex-users (n = 17)	4.00	4.00	0.00

Since the datasets were not normally distributed and referred to within-subject data, and also due to appropriateness of running non-parametric statistics for ordinal data (Robertson, 2012), we run the two-tailed Wilcoxon signed-rank test to determine if there would be significance difference in motivation over time per group of ex-users and current-users. Among *all participants*, last motivation (*Mdn* = 5*)* was significant higher than initial motivation (*Mdn* = 3) $Z = 10.306$, $p < .001$, $r = .40$.

For the *current users* group, there was also a significant difference in motivation over time when comparing last motivation (*Mdn* = 5) to initial motivation (*Mdn* = 3), Z =10.35, p < .001, r = .41.

To test whether the same behavior would occur within current users using their devices for one year or more (n = 204), we applied the same 2-tailed Wilcoxon signed-rank test and also found that last motivation was (*Mdn* = 5) was significantly higher than initial motivation (*Mdn* = 4), Z =*8.5892*, p < .001, r = .43.

Within the group of ex-users, however, we did not find significant differences between last (*Mdn* = 4) and initial (*Mdn* = 4) motivations, Z = 0.68525, p = .51, r = .12.

To illustrate the most recent motivation participants had with their activity trackers, Figure 5 shows a scale with 5 levels, from low to high levels of motivation and quantity of participants at each level as they chose in the survey. We run Fisher's exact test to compare differences of last level of motivation between current users and ex-users, since the Chi-squared approximation could be incorrect due to frequency less than 5 for some levels of score and groups. The Fisher's exact test revealed that the perception of motivation is significantly different (p = .002) between these groups.

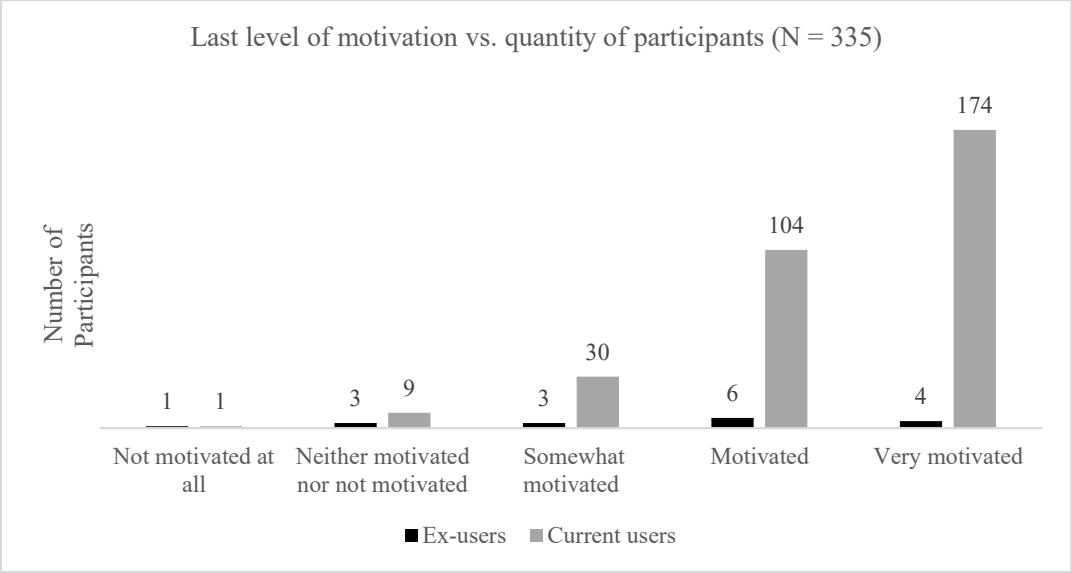


Figure 5. Current users and ex-users - level of last motivation experienced with their devices

Through the interviews, participants explained that their motivation changed over time as the novelty of the using a device goes away:

> *At first it's different now than when I first got it "Oh I've gotta get 10k steps" or "I've gotta get that goal everyday". Every day you can look at the app and you can see that "hey look I made my goal 6 out of 7 days this week", or "oh look, I didn't get my steps in, I need to get my wear and gear" and all that. Now it's only on me and I don't track it through the app as much, it has become less user friendly with updates* (P2, age 36-45, 10 months of use).

> *The first several days I felt really happy [*about badges and rewards*] but after a while like a hundred days, you know, it's gonna be just like the same.* (PX1, 26-35, Jawbone UP2, 3 months, ex-user but using again).

> *[In the beginning I checked data] 3 times a day, sometimes every single hour, because since I wanted one and I just had got as a gift, I was super excited about it; I thought "oh it's super cool, all this data, all these graphs, it's super nice" […] [Now] I wear it every day, but check the data each 2 or 3 days, maybe 2 or 3 times a week.* (P6, 18-25, 48, Fitbit Charge HR).

As the novelty fades, begin to consider questions about usefulness of the devices and reflect on their goals versus the outcomes they can get from the use of their devices:

> *You get in love with it, right? 'Cos it's just interesting and fascinating to watch the data, so for the 3 months or so [… then] I started to fall out of love with it a little bit, but not because I didn't want to hit my goal every day, but because there is limited amount of time I can do exercise every day, and the high intensity interval training didn't give me any points, so I said no, I couldn't do that which gives me the best workout […] then I found that I wasn't in as a good shape 'cos I was doing less effective workouts in order to be mastered by this, to get the goal every day.* (PX2, 45+, ex-user, 1.5 years using a Misfit Shine, stopped due to the lack of tracking HIT workouts).

Despite the loss of the initial excitement, users' reflections on usefulness in some cases increased the attachment to their devices:

> *When I bought it I thought it maybe was a toy. I've had pedometers before and I wasn't really sure if I would stick to it, but some of my friends had and we all talked about it so I gave it a try. But it's not a toy, I've discovered it's a more than a tool, and it's just as important to me as my cell phone, and I have to have it every day.* (P2, 45+, 2 years, Garmin Vivofit)

Other survey participants also explained that their motivation changed as their goals are achieved:

> *[Today I use it] mostly to gauge my activity and sleep. At first I used it as motivation to hit 10K steps but after several years the newness has worn off. I also like that MyFitnessPal is linked to it so I can monitor my food intake too.* (S190, 45+, more than one year, Fitbit Charge HR).

This participant, who had the single goal of weight loss, is another example of goals changing over time:

> *But once I got going, steps were not important.* (S182, 45+, 2 years, Fitbit Flex).

4.2 Ex-users - Reasons of Abandonment

4.2.1 Survey Answers

Only 10 out of the 17 ex-user participants (59%) provided brief explanations for the question "Why did you stop using your device?" Their responses could be classified into 5 categories: i) usability issues; ii) malfunctioning; iii) loss-and-breakage; iv) changes in priority due to workload; and v) new behavior achievement. Table 7 indicates these categories and

related participants' reasons of abandoning their devices, time of use, the primary reason to use an activity tracker and whether their devices helped them or not to reach their goals. Also, this table indicates if the participant was interviewed by showing participants' code.

Table 7. Survey ex-user participants' main characteristics of use and reasons to stop using their activity trackers

Category of abandonment	Reason to stop using	Time of use	Primary reason to use	Device helped to achieve goals	Interviewee
New behavior achieved (10%)	Habit achieved	9 months	Intrinsic: alarm clock	Yes	PX3
Changes of priority (20%)	Lack of time due to workload	6 months	None	Yes	-
		3 months	None	Yes	-
Usability issues (30%)	Lack of functionality (device did not track HIIT[2] workouts)	18 months	Intrinsic: take better care of health	Yes	PX2
	Uncertainty about accuracy	4 weeks	None	No	-
	Lack of comfort (wrist feels sweaty)	3 weeks	Intrinsic: accountability	No	-
Malfunctioning (10%)	Device did not work properly	4 weeks	None	No	-
Loss-and-breakage (30%)	Break	3 months	Intrinsic: take better care of health	Yes	PX1
	Loss	2 years	Intrinsic: accountability	Yes	-
		3 months	Intrinsic: curiosity	No	PX4

4.2.2 Interviews

The four ex-users who were interviewed complemented the information they provided in the survey explaining what made them stop using their trackers. Two of them, PX1 and PX3,

[2] High Intensity Interval Training

who declared in the survey decreased levels of motivation over time, had resumed using their devices by the date of the interview. The other two, PX2 and PX4, declared their motivation was the same when they started using but were not sure they would use an activity tracker in the future again.

The interviewees are portrayed in Table 8, which indicates the model participants used, their age and gender, and the initial and last levels of motivation as they perceived when dealing with their devices.

Table 8. Ex-user interviewees' profile

Participant	Model	Time of use (weeks)	Age	Gender	Initial level of motivation	Last level of motivation
PX1	Jawbone UP 2	13	26-35	Male	Motivated	Neither motivated nor not motivated
PX2	Misfit Shine	78	45+	Female	Motivated	Motivated
PX3	Jawbone UP 24	39	18-25	Female	Very motivated	Somewhat motivated
PX4	Jawbone UP Move	9	26-35	Male	Somewhat motivated	Somewhat motivated

One of the participants, PX3, stopped using her device when the battery ran out, which triggered a reflection about the actual need to keep using it. Her goal was to adjust her times of sleep, by going to bed at a particular time and waking up on a regular basis. She achieved her objective; however, charging seemed effortful and not worth to keep using her tracker. When asked why she was wearing it again, PX3 explained:

> *Actually I was answering the survey, and it reminded me how things were before, and this week I'm really busy so… sometimes I cannot go to sleep that early, so I need something to remind myself: "you need to finish your work quickly, and you need to get back to the good habit"; last week I went to bed very late, so I did not feel so very good during the day […], so I started using it again.*

PX3 added that once she reaches her goal, she will probably stop using her device again.

PX1 had a different experience but was also wearing his tracker during the interview. He explained that after 3 months of use a connection in the band broke, which was the reason to stop using his device. It took one month to have the tracker replaced. However, PX1 did not immediately restart using due to lack of interest. When asked why using again, he said: “It doesn’t make a difference to wear it or not, it’s pretty nice and comfortable; also, it’s a passive collection of data”. PX1 also commented that he checks data only occasionally per his curiosity only, and that he does not use the data to make decisions about what would be needed to be more active. He stated that his workload drives his priorities:

> *It's not like wearing a band can make you do a lot of things more, it's your schedule, your workload, if you have so much work to do you can't go to the gym, you can't go to sleep.*

Another ex-user interviewed, PX2, stopped using her tracker after 1.5 years due to lack of functionality to tracking high-intensity interval training workouts (HIT), which she was used to practicing before buying her device. She was already an active person, mainly during summer when the weather incentives her activities outdoors, such as biking or walking. Since her activity levels were reduced during winter times, she decided to use an activity tracker to be accountable and motivated on exercising. Despite liking her device very much, over time she noticed that she was replacing the HIT workouts by walking, so the device would credit activity points:

> *So I spent the whole year and I got my goal that year 'cos I couldn't change my goal once it's set, and then I found that I wasn't in as a good shape 'cos I was doing less effective workouts in order to be mastered by this, to get the goal every day* […] *if it would give my points to the intervals, I'd still would use it every day. That's the reality, 'cos I did love the tracking, I loved the sleep tracking, I loved all about it.*

Even though PX2 enjoyed her tracker, she has no plans to use it again, unless it could track HIT workouts.

The last interviewed participant was PX4, who was also an active person before start using his tracker, that he bought only due to curiosity and fun to check the data collected. His device was not waterproof, and was lost when it fell into the toilet. Due to lack of perceived utility, PX4 has no intention to have another tracker again. When asked about if any change in his routine was seen, he answered: “Not really, I just noticed like when I was low in steps, I'd park further away from the parking lot”.

4.3 User Expectations in Using Activity Trackers

In this section we examine the extent to which activity trackers matched participant goals. We also examine user satisfaction with their devices.

4.3.1 Initial Goals vs. Device Capabilities

In order to compare participant’s initial goals to their devices capabilities, participants were asked the multiple-choice question “What were your goals before starting to use your device?”, from which they could select as many items as were their goals from the following list: “Exercise more”, “Lose weight”, “Count or track steps”, “Count or track distance”, “Track heartbeat”, “Track calories”, “Track sleep”, “Alarm clock” and “I did not have any goals”. After comparing users’ models specs against participants’ initial goals, we found that only 6 expectations would be unreasonable: 4 out of the 51 who wanted to track heartbeat would not be able to track it, since their devices did not track heart beat (8%). 17 expected an alarm clock; of these, 2 were using models without this function (12%). Table 9 shows the number of participants who selected each of the functionalities as their initial goals, as can be seen in the first row “Initial goals”, and the related total of unmatched expectations considering their models’ specs (second row, or “Unrealistic expectations)

Table 9. Quantity of participants' choices for initial goals vs. unrealistic expectations on their devices capabilities

	Track steps	Track distance	Track heartbeat	Track calories	Track sleep	Alarm clock
Initial goals	203	81	51	64	131	17
Unrealistic expectations	0	0	4	0	0	2

These numbers indicate that, contrary results reported by Lazar et. al. (2015), it is apparent that many of our survey participants were aware of their devices' capabilities prior to acquisition; in order words, they knew what they wanted. Some interviewees confirmed this assumption, by reporting how they decided for their models: having an alarm clock without sound (PX3 – Jawbone UP24); tracking steps and sleep with comfort and elegance (PX1, Jawbone UP2); long battery life (P1, P3, P5 – Misfit Shine and Garmin Vivofit); waterproofness (P3, P5 – Misfit Shine).

Regarding the survey participants who had initial goals incompatible with their devices, we analyzed how long participants used/were using their activity trackers, their levels of motivation and any comments they provided for the open-ended questions in the survey. Our goal was to understand if the lack of expected functionalities would affect abandonment or motivation. Table 10 includes these participants time of use, their models, and their reported initial and last motivations.

Table 10. Participants and their unmatched expectations about their devices' capabilities

Functionality expected	Current or ex-user	Model	Time of use	Initial level of motivation		Last level of motivation
Track of heartbeat	Ex-user	Jawbone UP Move	4 weeks	Somewhat motivated	↓	Neither motivated nor not motivated
		Fitbit Charge	10 months	Motivated	=	Motivated
	Current users	Misfit Shine	2 years	Motivated	↑	Very motivated
		Misfit Speedo Shine	2 years	Somewhat motivated	↑	Motivated
Alarm clock	Current user	Garmin Vivofit	1.5 years	Very motivated	↓	Motivated
			2 years	Very motivated	↓	Somewhat motivated

Among those participants who initially wanted to track their heartbeat, we found that 2 were using their Misfit devices for 2 years with increased level of motivation over time. The other two were ex-users: one did not leave reasons of abandonment of their Fitbit Charge after 10 months of use, and reported same levels for initial and last motivation; the other participant was an ex-user of a Jawbone UP Move, who attributed little accuracy as the reason to stop using their device after 4 weeks; this was the single participant within those who expected to track heartbeat that reported decreased motivation over time.

Hence, it is unlikely that these 4 participants who expected to track their heartbeat were impacted by the lack of this functionality since no comments were provided that could be associated with the lack of heart tracking function. Or at least, it is possible that tracking heart beat was not these participants' primary priority considering also that, for 3 of them, the time of use was 10 months or more with no decreased motivation.

Regarding alarm clock, decreased levels of motivation were observed among 2 participants of Garmin Vivofit, but there were no comments provided that could relate this decline with the lack of alarm in their devices. In addition, these are also example of long-term use; therefore, it is very unlikely that the lack of alarm could have influenced their decisions on

stopping using their trackers, since they there using their devices for 1.5 years or more, despite the reduced motivation over time.

4.3.2 Participants' Satisfaction with their Devices' Characteristics

In order to investigate possible usability issues that could have affected participants' engagement on adopting their devices or influenced their motivation, first, we identified participants' overall satisfaction with several aspects of their devices (see Table 9). For each participant, we summed the levels of satisfaction (from 1 to 5) reported to each of the 9 aspects of their devices and then calculated the medians for each group (*ex-users* and *current users*). Overall, the survey participants reported fairly high satisfaction levels (*Mdn* = 38). When examining satisfaction in terms of whether or not the participant was still using their device, the *current users group*, not surprisingly, reported higher levels of satisfaction (*Mdn* = 39), than did the *ex-users group* (*Mdn* = 34). In order to compare the levels of satisfaction between *current users* and *ex-users* group, we run the Independent-samples T-test and found significant difference between groups ($t_{(17)} = -3.28$, $p = .004$)

The participants' lowest satisfaction refers to the Likert scale options "very unsatisfied" and "unsatisfied". Table 11 indicates the number of participants gave these low satisfaction ratings on specific aspects of their devices; the column labeled as "rate" indicates the number of participants that declared dissatisfaction divided by the total number of answers for that given device characteristic.

Table 11. Aspects of participants' devices related to low satisfaction

Devices' aspects	# Participants dissatisfied	Total # answers	Rate
Battery life	38	330	12%
Sync	31	329	9%
Aesthetics	27	330	8%
Accuracy	18	331	5%
Sharing data	16	321	5%
Comfort	16	329	5%
Data in app/web	15	322	5%
Data in device	14	324	4%
Price	10	330	3%

We looked to see whether these scores for satisfaction would be related to reasons of abandonment among the group of ex-users by comparing participants' score comments with the responses to this question. However, we found only 2 matches of low satisfaction levels and reasons for abandonment. One participant reported low satisfaction with accuracy which was the reason attributed to stopping using their tracker after 4 weeks, and another ex-user declared their product never worked properly, which was associated with low satisfaction with all aspects of this participant's device, except price which was related to "neither satisfied not dissatisfied."

We also looked at whether there was any correlation between reported satisfaction and changes in motivation over time. As shown in Table 12, for ex-users, the only statistically significant correlation between satisfaction and motivation over time was for device synching, indicating dissatisfaction with the need for synching. For current users, the only significant correlation was with having data in the device. For these users, the fact that data was stored on their device was considered beneficial.

Table 12. Spearman correlation – Differences between levels of motivation (last – initial) vs. general aspects of activity trackers, per groups of ex-user and ex-users

	Difference between last and initial motivation	
Satisfaction with	**Ex-users**	**Current-users**
Data in device	$r_{(12)} = .500$, $p = .069$	$\mathbf{r_{(308)} = .123, p = .030}$
Data in app/web	$r_{(11)} = .252$, $p = .407$	$r_{(307)} = -.022$, $p = .696$
Sync	$\mathbf{r_{(13)} = .763, p = .001}$	$r_{(312)} = .045$, $p = .427$
Sharing data	$r_{(13)} = .379$, $p = .164$	$r_{(304)} = .103$, $p = .071$
Accuracy	$r_{(15)} = .165$, $p = .526$	$r_{(312)} = .103$, $p = .070$
Battery life	$r_{(15)} = -.175$, $p = .502$	$r_{(311)} = .034$, $p = .545$
Comfort	$r_{(15)} = .262$, $p = .309$	$r_{(310)} = .063$, $p = .266$
Aesthetics	$r_{(15)} = .139$, $p = .594$	$r_{(311)} = -.086$, $p = .127$
Price	$r_{(15)} = .360$, $p = .156$	$r_{(313)} = .051$, $p = .369$

4.4 Reasons for Device Satisfaction

The responses for dissatisfaction for *all participants* were compared to answers on "What do you dislike the most in your device?" Excluding battery life that was cited by 12% of the participants, there was little commonality among the reported reasons for dissatisfaction.

Regarding battery life, reasons for dissatisfaction were related only to products that require charging only. No participant reported dissatisfaction with products such as the Misfit and Garmin Vivofit that use coin cells, having a battery life of months. Thirty-six participants' dislikes were related to battery; 34 dislikes were for battery life, one due to a sensitive port which easily broke, and another participant commented about having to take the device out before taking showers since it is not waterproof.

Regarding syncing, there were 31 comments related to dissatisfaction and 22 dislikes that were related to other issues and frustrations. Stated reasons for dissatisfaction were:

- Synchronizing users' trackers with computers, tablets or smartphones;
- Long syncs;
- The need to manually start the sync process;

- Cell phone unresponsive during the syncing;
- The need to leave the Bluetooth on in order to sync automatically, which consumes significantly battery from the cell phone;
- Some products' issues when synchronizing with Android phones; and
- The need of an ANT stick which is tiny, easy to lose and expensive, reported by one participant that uses a Garmin Vivofit.

Aesthetics was the third aspect in the rank of dissatisfaction, cited by 27 participants. Only a few, however, left comments such as: "bulky", "ugly" or "oddly. One of our participants in the current user group, P2, also mentioned during the interview that she would like her Garmin Vivofit could be a little more elegant to so she could wear it without having to hide it under clothes on special occasions.

Regarding accuracy, 18 participants were not satisfied; 17 reported disliking about some types of data collected that do not match their expectations. This mismatches with expectation include issues about accuracy of steps taken, distance traveled, the number of floors climbed, and sleep. One participant commented that their tracker is not accurate when worn under clothes; another wrote that in order to get correct measures, their device should be worn on the ankle.

Sharing data was as a reason for dissatisfaction by 16 participants. No comments, however, were written about sharing issues. One participant mentioned "friends don't have one," that may be associated with this aspect of sharing, but there was no detail provided to confirm this conclusion. Contrary to previous studies (Fritz et al., 2014, Harrison et al., 2015, Shih et al., 2015), our interviewees typically did not have interests in sharing their achievements or competing with others online. Only P6, reported participating in a WhatsApp group to share her achievements with her friends with similar interests. Also, only 7 out of 92 in the complementary

survey stated that competition was their reason to use their devices; only 6 wrote comments on the "likes" question that are related to competition or social interactions.

Comfort was another characteristic that was not directly associated to the participants' dislikes. While there were 16 reports of dissatisfaction, only 2 dislikes were related to comfort, in which one participant mentioned that during hot weather, their wrist feels sweaty.

Dislikes about display were cited by 8 participants, which were related to the absence of interface on the device, information presented in lights rather than numbers, and display always on.

About data in apps, participants commented that differences on how information is presented in the cell phone apps and web versions may cause frustration. One participant reported that since an app update, it is not possible anymore to check their ranking among groups in the smartphone as the current app only shows the top 20. Since this participant does not have a computer, they cannot check their rank position in the groups anymore. Apps updates were also mentioned by P4 as an issue in her interview. P4 commented she reduced the frequency of checking her data in the app. She relies on the lights in her Misfit to check her activity levels: "[…] now I don't track it through the app as much, it has become less user friendly with updates, so it's just kind of there for me now." Regarding likes, 26 participants provided comments that they like their apps very much and that they are easy to use.

Other comments that relate to low satisfaction in regard to data in apps were unspecified difficulties to use, the absence of notifications in the smartphone, and having to use a cell phone to set the alarm clock. This setting of the alarm clock was a PX3 issue clarified during the interview, when she counted 12 gestures to set her alarm from turning the Bluetooth on, setting the alarm in the app, and turning the Bluetooth off. Although she was not satisfied with the

number of gestures to do this setting, PX3 still perceives this setting as worth it, since an alarm clock with vibration was her primary purpose of acquiring her activity tracker due to the need of changing her sleep habit.

Despite 10 participants reporting being "not satisfied" with the price, no comments on price were provided in participants' answers for the dislike question.

Regarding participants' main likes, 84 are related to accountability about steps tracking and sleep tracking. There were 26 related to waterproofness, and the fact that there was no need to remove the devices for showers or swimming.

4.5 Primary Reasons: Impact on User's Motivation over Time

To test whether primary reasons would influence levels of motivation over time, two coders categorized participants' answers in intrinsic or extrinsic motivations. Since we found that there was no ex-user participant with extrinsic motivations, we limited this analysis within the current users group, which was separated in intrinsic or extrinsic groups.

The extrinsic (n = 15) and intrinsic (n = 302) groups were then assigned to the differences between last and initial motivations reported. Our hypothesis was that intrinsic motivation as primary reasons would impact users' levels of motivation overtime. Therefore, we run the two-tailed Mann-Whitney *U* test, since the data was not normally distributed and the sample sizes were different. Nevertheless, no significance was found when comparing levels of motivation over time between the extrinsic and intrinsic groups ($U = 2959$, $p = .098$).

4.6 Forms of acquisition

This study initial hypothesis about forms of acquisition was that devices that were got as a gift would influence abandonment and would impact motivation by decreasing levels over

time. However, only 3 ex-users got their devices as a gift, which restricted the test of this influence. Hence, we considered the group of all users, in order to verify the impact of forms of acquisition on motivation. This resulted in two groups: "gift" (n = 86) with all participants that got their devices at work or got as a gift; and "bought": (n = 244) that contained all participants that purchased their devices. Five participants were not included in any of these groups since one had built their own device, another was not specific, and 3 mentioned they had acquired both by purchase or got at work.

The differences of last and current motivations were calculated (both groups had a median of 1 and mode of 0), and contrary to what was expected, there was no statistical significant difference in motivation over time between those who had received their device as a gift and those who had purchased their own devices ($U = 39225$, $p = .128$).

4.7 Why Do People Use their Activity Trackers?

From the complementary survey designated to current users, we got 92 responses. Among these, 65 participants (71%) had been using their devices for more than one year, 21 from 3 to 11 months (23%), and 10 participants for less than 3 months (11%).

A total of 77 answers to the question "What makes you use your activity tracker" were related to accountability. While some participants were explicit about what kind of data they use for their devices, some just said "accountability" implicitly or in general terms, such as in:

> *It helps keep me honest as to how much activism getting in a day.* (S285, age 36-45, 2 years of use).
>
> *I enjoy being able to track data trends according to lifestyle changes I make over time.* (S195, age 26-36, 2 years).
>
> *Being accountable to myself. Being honest with myself about how much I am actually moving.* (S207, age 45+, 1 year).
>
> *Data driven health improvement.* (S132, age 36-45, 1.5 years).

Often, two or more factors were combined in participants' responses:

> *A desire to move more; to stay healthy and fit as I age.* (S70, 45+ years old, 9 months using her activity tracker).

> *I have started a 365-day challenge, to burn one million calories. I need to track my daily calorie expenditure. I also want to improve my fitness and reduce weight.* (S48, 45+ years old, 26 weeks).

Table 13 comprises categories obtained from the 92 *current user* participants' who took the complementary survey. Except by the 3 last reasons in this table (waterproofness, aesthetics, and watch), all of the answers can be directly or indirectly related to actions that can improve health.

Table 13. Reasons to keep using an activity tracker

Reason to keep using	Qt. of participants
Accountability	
To move or exercise more	35
To check data (not specified)	21
To track sleep	14
Calories - intake or expenditure	8
Weight control	5
Reminder to move	3
To track distance	2
To track heart beat	2
Get motivation or participate in challenges	15
Desire to be healthier	12
Compete with others	7
Waterproof (never take it off)	1
Aesthetics ("looks cool")	1
Watch	1

Considering the number of answers related to accountability and health control, it is likely that our participants are conscious that being accountable presents the opportunity to make proper choices towards their objectives. Participants recognize that this awareness incentivize them to keep on the path of their objectives. Our interviewees stated, for example:

> *It keeps me motivated throughout the day. I know where I need to be step-wise at different points in the day to know if I'm on track to meet my goal.* (P4, 36-45, 10 months, Misfit Shine).
>
> *Somehow having the steps, and having that information right on my wrist encourages me to keep active all throughout the day.* (P2, 45+, 2 years, Garmin Vivofit).
>
> *I think humans are relatively simple, and just having this little thing on my wrist, and if I hit my target all the lights will flash; for some reason, that is really pleasing.* (P3, 45+, 2 years, Misfit Shine).
>
> *When I look to the data I can see how active I was throughout the month or so; then I can take proactive steps in order not to be sedentary [anymore]*. (P6, 18-25, 10 months, Fitbit Charge HR).

In addition, some of our interviewees experienced a lack of ability to self-regulate themselves when they decided to stop using their devices. This relates to the ex-user PX3 experience, who restarted using her tracker as reminder to control her sleeping times again, and by P4 who is a current user that judged her habits regarding physical activity were mastered, so she could stop using her device:

> *I got to avoid [my activity tracker] when I thought "ok, my habits are good, and I'm gonna try to go without it"; then I immediately fell back into the bad habit. Just like, I'd say it's the same thing like when you diet, when you get off your diet, and think "oh I can maintain this way now", no! You're not going to maintain the weight.* (P4, 45+, 10 months).

Most likely our participants recognize that changing behavior requires self-monitoring, as per their statements that accountability is the main reason for them to keep using their trackers. It is plausible to consider that our participants' experiences brought them consciousness about the extent their trackers influenced their behavior change, by providing the information they could use to self-regulate themselves. This was the reason why PX3 and P4 adopted their trackers again. Our participants' thoughts are examples of what the science of behavior change posits about self-monitoring, which is the central key to controlling a new behavior, even for long-term changes (Klasnja, Consolvo and Pratt 2011).

Our interviewees identify the use of their trackers as effortless. When P5 was asked why she still uses her tracker for 2 years, she answered:

> *It's brainless, I don't have to take it off, if I'm being really lazy I can sync it once a week.* (P5, age 26-35, 2 years; Misfit Shine)

In addition, P5 complemented that Misfit can recognize through the sync process when their users' devices are running out of battery, and sends users a battery for a replacement for free, preventing users to spend time without using their products.

In the survey, one participant declared similar perception of effort and benefit:

> *Simple, easy, no brainer. Motivation. "You can't manage what you can't measure." (*S56, 45+*,* more than one year; Fitbit One*)*

Regarding weight control, only 5 participants declared their trackers are in use to help them to control or lose weight, and only 2 among these are using their devices for more than one year. These numbers contrast to the 65 participants within this same group of 92 respondents that declared weight loss as one of their initial goals in the first survey. Reasons for this discrepancy may be that weight loss was not the top priority within these participants' initial goals, or that participants could have achieved some weight loss and now aim to keep track to maintain their weight or just remain active.

The survey participant S160 is an example of this change of goals over time. In the first survey, she wrote: "lost 85 pounds, reduce bp [blood pressure]!!", and in the complementary survey, she answered: "Makes me accountable to staying on track for my fitness goals...and it looks cool" (S160, 45+, one year or more, Misfit Shine).

Similarly, S18 had the goal of weight loss, and also to exercise more. Her comment about goal reached was: "lost 60 lbs, sleep better, healthier", and to answer what makes she use her activity tracker, she simply stated: "Competing with others." (S18, 45+, 3 years, Fitbit Zip).

Our interviewees also comment about weight control as a goal that changed over time:

> *I think originally I did lose [weight] a little bit, at this point my main goal for keeping it is to just keep track of where I am, it's not something I look at too often.* (P5, 26-35, 2 years, Misfit Shine)

P2 recognizes that the activity tracker alone would not be enough for her to lose weight, but was important to start the process of weight loss which depends most on diet, as she points out:

> *[The weight loss] was a change in diet and the tracker was just kind of a motivation to kick-off, getting more fit and everything, it was like "hey, now I can see that I can get my 10 or 12 thousand steps in the day, maybe I will have that salad instead of that bowl of ice cream". [The activity tracker]is always there, it's like a constant reminder of "hey, is that a smart choice" or that kind of thing, so I do attribute it helping with that a little bit but not so much because of the number of steps but more as a constant reminder of "hey it's right there".* (P2, 36-45, 10 months).

5 Discussion

In this section, we answer this study's research questions and discuss this work's limitations. To anticipate, it is worth keeping in mind the characteristics of the participants in this study. Specifically, they primarily were recruited from online groups of people who used activity trackers. This means that the current results cannot address questions of percentages of those who get activity trackers who do and do not adopt them long term. Rather, this work seeks to uncover factors that foster long-term usage. In many cases, participants in this study had been using their activity tracking devices for several years.

5.1 RQ1: Which factors might discourage users of wearable activity trackers from continuing to use their devices?

In order to answer this research question, 3 points were considered: i) we analyzed whether discrepancies between participants' initial goals and their devices capabilities would impact the use of their devices; ii) we examined participants' low levels of satisfaction regarding aspects of their activity trackers and looked for related usability issues among participants comments; and lastly iii) we analyzed ex-user participants answers to the question "why did you stop using your activity tracker?".

Regarding devices' capabilities, while Lazar et al. (2015) found that their participants often did not purchase a device that would map their goals, our results suggest that, except for 6 of our participants, all were aware of the models' characteristics that they decided to use, since their devices were capable to address their objectives. This result may be due to the low number of participants within the ex-users group from which we actually could obtain this influence of unmatched expectations. It is also likely due recruiting that resulted in the majority of participants being enthusiastic users of their activity trackers. However, our finding suggests

that a clear purpose to start using a device and an appropriate choice of a model that can address this objective may support engagement for long-term adoption.

5.1.1 Users' Reflection on Usefulness

Concerning satisfaction, our participants' lowest scores were given to battery life. However, we did not find participants that stopped using their devices because of the need to charge or change the battery. On the other hand, we noticed that the perceived effort to charge may trigger reflection about the real need to keep using a given device. While previous work states battery life as a critical factor for adoption within initial use (Harrison, et al. 2015, Lazar, et al. 2015), battery life can still be discouraging for long-term users that are habituated to charging their devices. Moreover, experiencing running out of battery may be even more critical for those who need to replace their coin cells, since it requires an additional effort to purchase the new battery and replace it. It is likely that this issue may be known by some companies such as Misfit. As P5 reported, Misfit sends their users a replacement battery when their servers recognize that consumers' battery are running low, therefore preventing consumers from being without the device.

Overall, syncing had the second lowest satisfaction rates among our participants, and while Lazar et al. (2015) found that issues with syncing can cause abandonment in short-term use, we found that it also can be discouraging for long-term users. For instance, due to sync issues with P3's new Android phone, P3 (a 2-year user) gave up on using her device for 2 months, even being able to check her activity levels on her device.

Hence, even long-term users can be discouraged from continuing using their devices if they are triggered by situations that make them reflect on the sense of usefulness of their trackers. This reflection is reasonable and legitimate; however, our participants also perceived

that during the period they did not use their devices, they fell back into the old and undesirable habits, due to the absence of their aid for self-regulation. Due to this experience, some of our participants declared they do not wish to stop using their devices again.

Regarding our 10 ex-users' motives to suspend using their trackers, loss-and-breakage, and usability issues were their main reasons to stop. Although loss-and-breakage are involuntary reasons that prevent people from using their devices, these events also promote a non-use period with consequent reflection on device usefulness.

5.1.2 Usability issues

Concerning usability issues, two participants decided to stop using their trackers by the fourth week, which is similar to the time of use observed by previous studies on abandonment (Fausset, 2013, Shih, 2015). However, usability problems can also influence long-term users, such as P3 and P4, who had similar devices and experienced relatively similar problems. While P3 stopped using her Misfit for 2 months due to sync issues with her new Android phone, P4 decided to keep using and checking the data only in the device since the app updates made the system nonuser-friendly for her. This adaptation was not considered by P3. Despite the fact that P3 liked the device lighting up as feedback of her achievements during the day, the perceived value of continuing to use her device without the app was not enough as it was for P4. Hence, these long-term users, who own the same model, perceived differently the usefulness and effort needed to keep using their devices without the app.

Another usability issue was accuracy, which is recognized as a critical factor that can prevent engagement (Lazar, et al. 2015, Fritz, et al. 2014, Consolvo, et al. 2008). We had only one user who stopped using their tracker due to uncertainty about their device's accuracy by the

fourth week of use. However, a total of 18 participants were unsatisfied with this aspect of their devices.

Regarding the lack of time, two of our ex-users stopped using their trackers by the third and sixth month of use. The lack of time also affected P6, a long term user who reduced her physical activity levels but decided to keep using her tracker to check data throughout the months. According to Klasnja, Consolvo and Pratt (2011), external pressures such as high demands of work can obstruct the self-regulation for a behavior change. However, while some users give up on their devices due to change of priorities, others keep using their devices instead of canceling or temporarily suspending their use, which can contribute to resuming activities.

5.1.3 Balance Between Usefulness and Effort to Maintain the Devices

These differences suggest that while some users can live with issues regarding their devices or situations, others cannot. This suggests that what influences users' decisions is the perceived difference between the sense of usefulness and the necessary effort to maintain the device. If the effort to maintain is higher than the sense of usefulness, the abandonment is imminent; on the other hand, if the sense of usefulness is higher than the effort to keep the device, this opens the path for the long-term adoption.

5.2 RQ2: How does these users' level of motivation may be changed over time?

In order to answer this research question, we analyzed: i) differences between last and initial motivation; ii) impact of primary reasons on motivation (intrinsic/extrinsic); and iii) if forms of acquisition would influence users' motivations as well.

Overall, this study's *current user* participants started somewhat motivated, and had their motivation increased over time. Some participants reported that the novelty from the beginning

was lost and the frequency of checking data was reduced, which confirms Lazar et al. (2015) and Fritz et al. (2014) findings. However, while Lazar et al (2015) noticed reduced motivation of use over time among their participants, Fritz et al. (2014) noted high excitement among their interviewees even after months or years of use. Our study adds by comparing our current users' initial and last motivations, which was increased even among those using their devices for one year or more. On the other hand, our ex-users group, overall, did not have reported changes in their motivation levels.

Regarding extrinsic and intrinsic motivations, due to the very limited participation of ex-users, we had no ex-users that were associated with extrinsic motivations; therefore, we limited our analysis considering the current users group only. Inspired by previous studies, we hypothesized that users' initial intrinsic motivations would influence levels of motivation over time more positively than extrinsic motivations would. However, statistical tests indicated no significance, which may be due to our samples which mostly contained high motivated participants, as per their excitement using their devices.

Stimulated by Harrisson et al. (2015)' findings on abandonment rates, we also hypothesized that participants who bought their own devices would have more motivation over time than the users who got their devices as a gift. Nonetheless, we did not find statistical significance, possibly due to the number of highly motivated users. Moreover, as per our P6 example, the willingness to use an activity tracker may result in receiving a device as a gift from others, therefore the form of acquisition itself may not affect motivation as much as the willingness to using an activity tracker may. Future studies can better investigate whether these differences may affect engagement or motivation over time.

The data from the interviews suggest that our participants had a clear understanding of the importance of their trackers in their routines, and that using these devices was not time consuming. This perceived usefulness and the sense of low maintenance required to use their devices contributed to their long-term engagement.

Several studies have indicated that devices that require high levels of maintenance are likely to cause abandonment in the very first weeks of use (Fausset et al., 2013, Harrison et al., 2015 and Lazar et al, 2015). In this study adds that this effect can also affect long-term users, who are likely to resume using their devices if they step back into the old habits. The effort to maintain a device is often related to prompt access to meaningful data, long battery life, quick sync and for some participants, waterproofness. Except for a few, our interviewees have no intention to stop using their trackers, and some (P1, P2 and P6) reported that their devices were at least as important as their cell phones, and P2 specifically declared a closer relationship with her activity tracker than she has with anybody else, since she permanently uses her device as, in her own words, a "baby sitter" that reminds her to push to exercise.

5.3 RQ3: Which factors might support users in incorporating an activity tracker in their daily routines in the long-term

This research question was answered by analyzing the current users' answers to "what makes you use your activity tracker?", also by the data from the interviews, and insights from answers to the RQ1.

Our participants were particularly motivated and satisfied with their activity trackers and outcomes, and for the majority of our survey participants, the accountability that their products provided was the main reason that contributed to a continuous use. However, we also found that our survey participants wanted to change some behavior and that they had a clear purpose in

mind which drove them to acquire their specific models. Thus, these users' choices may have prevented them from experiencing frustrations that other users from previous studies may have faced at initial use. In addition, the reported excitement at the beginning of use may have eased the typical effort related to self-regulation that is needed to change behaviors.

Therefore, we suggest that the willing to change and a proper product that address users' needs help to prevent potential frustrations which can be related to the product in use or to the desired behavior which was not achieved. Moreover, the initial excitement of using a new device can support users to overcome the burn of the adaptation to the new scenario.

When the novelty is gone, which occurs by the second or third month according to our participants, users can observe if any changes occurred that would lead them towards their target. If users observe gains in using their devices and this use requires minimum effort (or an effort that the user can live with) it is likely that they will continue to use their devices and keep working towards the change they proposed to themselves. However, if difficulties in maintaining the device occur (charging the battery, interpreting data, unsuccessful sync, need to remember to wear or others), users can conclude that the effort to keep using their devices may be not worth it anymore.

Long-term users can also be discouraged to continue using their devices, as noticed by some of our interviewees. For two participants, the reason to stop using their devices was the achievement of the new desired habit; for another participant, sync issues with their new smartphone prevented them to continue to use their tracker. In both cases, participants noticed they fell back into the old habits, and then decided to restart using their trackers again so they would be accountable of their activities, which would ease their self-regulation towards their objectives.

According to these experiences, we can conclude that users who have stopped using their devices but had perceived gains while using their trackers can resume the use if they can compare their activity levels or the achievement of their goals in two periods along time: after and before stopping using their activity trackers. If the period using their activity trackers seems more promisor to the achievement of their goals, users are likely to resume using their devices. However, since this comparison may require some situation that triggers this thought, we suggest that the companies that design activity trackers support their users by developing kind notifications through users' preferable forms of communication (texts to users' phones, emails or mail address) that would be sent after their customers spent significant time without syncing their devices with the companies' servers. These notifications should contain a brief motivational message, preferably with a summary of users' achievements while they were using their trackers, or any other message that would trigger users' thoughts on how was their activity levels before the potential abandonment.

In summary, we suggest that the main factors that can support users' engagement for a long term use are: a personal and clear objective and a product that suits users' initial goals. Additionally, other factors that support engagement are accountability, an uninterrupted use, and a small effort needed to maintain a device in use in comparison to the gain perceived by the user. We found that long-term users can also experience abandoning their devices; however, these users may resume use after perceiving that their current activities levels are lower than when they were actually using their trackers.

5.4 Limitations

There are two significant limitations regarding the participations in this study. First, the very limited sample size of ex-users prevented the analysis on whether extrinsic motivations and forms of acquisition would influence abandonment over time. Second, our participants overall declared high levels of motivation and satisfaction with their devices that may not be representative of the entire population of users of activity trackers. Therefore, both low participation of ex-users and excitement among current users may be due the form we recruited participants in Facebook and Google+. Since we posted invitations in groups related to activity trackers, ex-users would be unlikely to be following these communities, and current users possibly would be engaged since they are members of the communities related to their models.

6 Conclusion

This work presented the results from an online survey and interviews designed to understand reasons that would discourage the use of activity trackers and factors that would influence long-term adoption. The results showed that the wearable activity trackers are overall enjoyable for both current users and ex-users. In addition, most of our participants acquired devices that would support them to reach their goals, and reasons for abandonment included usability issues, loss-and-breakage, and lack of usefulness.

Although we did not observe significant effects of some factors on motivation over time, some of our participants who were long-term users experienced temporary abandonment of their devices, whose use was resumed after these users noticed they have fallen into their old habits.

Therefore, we suggest that the key for long term use is comprised of, first, a clear purpose and a device that meets the individual's characteristics and needs; second, an effortless accountability of users' activity levels that is provided by their trackers; and lastly, a minimum effort to maintain these devices. In summary, whenever users notice that the effort to keep their devices is greater than the sense of usefulness, the abandonment is imminent.

To support users to resume the use of their trackers if these devices helped them to self-regulate a new desired habit, we suggest that the companies implement ways of identifying potential abandonment of use, which would trigger a kind message to these related users reminding them of their accomplishments while they used their activity trackers. We believe that this reminder can start a reflection among ex-users about their activity levels, supporting them to restart using their devices if they find it useful.

Finally, this study's findings add the understanding of how long term users deal with their devices and the barriers they may face over time. We believe that reducing usability issues

and offering users a way to reflect about their progress and accomplishments may support their self-regulation towards lasting healthy changes.

References

Apostolopoulos, Ilias, Daniel S Coming, and Eelke Folmer. 2015. "Accuracy of Pedometry on a Head-mounted Display." *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems.* Seoul, Republic of Korea: CHI '15. ACM. 2153-2156. doi:10.1145/2702123.2702143.

Consolvo, Sunny, David W. McDonald, Tammy Toscos, Mike Y. Chen, Jon Froehlich, Beverly Harrison, Predrag Klasnja, et al. 2008. "Activity Sensing in the Wild: A Field Trial of Ubifit Garden." ACM. 1797-1806. doi:10.1145/1357054.1357335.

El-Amrawy, F, and MI Nounou. 2015. "Are Currently Available Wearable Devices for Activity Tracking and Heart Rate Monitoring Accurate, Precise, and Medically Beneficial?" *Healthc Inform Res* 21 (4): 315-320. doi:http://dx.doi.org/10.4258/hir.2015.21.4.315.

Fausset, Cara B, Tracy L Mitzner, Chandler E Price, Brian D Jones, Brad W Fain, and Wendy A Rogers. 2013. "Older Adults' Use of and Attitudes toward Activity Monitoring Technologies." *Proceedings of the Human Factors and Ergonomics Society Annual Meeting.* SAGE Publications. 1683--1687.

Fritz, Thomas, Elaine M. Huang, Gail C. Murphy, and Thomas Zimmermann. 2014. "Persuasive Technology in the Real World: A Study of Long-term Use of Activity Sensing Devices for Fitness." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI '14.* Toronto, Ontario, Canada: ACM. 487-496. doi:10.1145/2556288.2557383.

Harrison, Daniel, Paul Marshall, Nadia Bianchi-Berthouze, and Jon Bird. 2015. "Activity Tracking: Barriers, Workarounds and Customisation." *Proceedings of the 2015 ACM*

International Joint Conference on Pervasive and Ubiquitous Computing, UbiComp '15. Osaka, Japan: ACM. 617-621. doi:10.1145/2750858.2805832.

Klasnja, Predrag, Sunny Consolvo, and Wanda Pratt. 2011. "How to evaluate technologies for health behavior change in HCI research." *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* 3063-3072. doi:10.1145/1978942.1979396.

Lazar, Amanda, Christian Koehler, Joshua Tanenbaum, and David H. Nguyen. 2015. "Why We Use and Abandon Smart Devices." *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing, UbiComp '15.* Osaka, Japan: ACM. 635-646. doi:10.1145/2750858.2804288.

Ledger, Dan, and Daniel McCaffrey. 2014. "Inside wearables: How the science of human behavior change offers the secret to long-term engagement." *Endeavour Partners.*

Mackinlay, Molly Zellweger. 2013. "Phases of Accuracy Diagnosis:(In) visibility of System Status in the Fitbit." *Intersect: The Stanford Journal of Science, Technology and Society* 6 (2).

n.d. *Obesity and Overweight.* Accessed Apr 20, 2016. http://www.who.int/mediacentre/factsheets/fs311/en/.

Robertson, Judy. 2012. "Likert-type scales, statistical methods, and effect sizes." *Communications of the ACM 55* no. 5: 6-7.

Ryan, Richard M, and Edward L Deci. 1985. *Intrinsic motivation and self-determination in human behavior.* New York: Plenum.

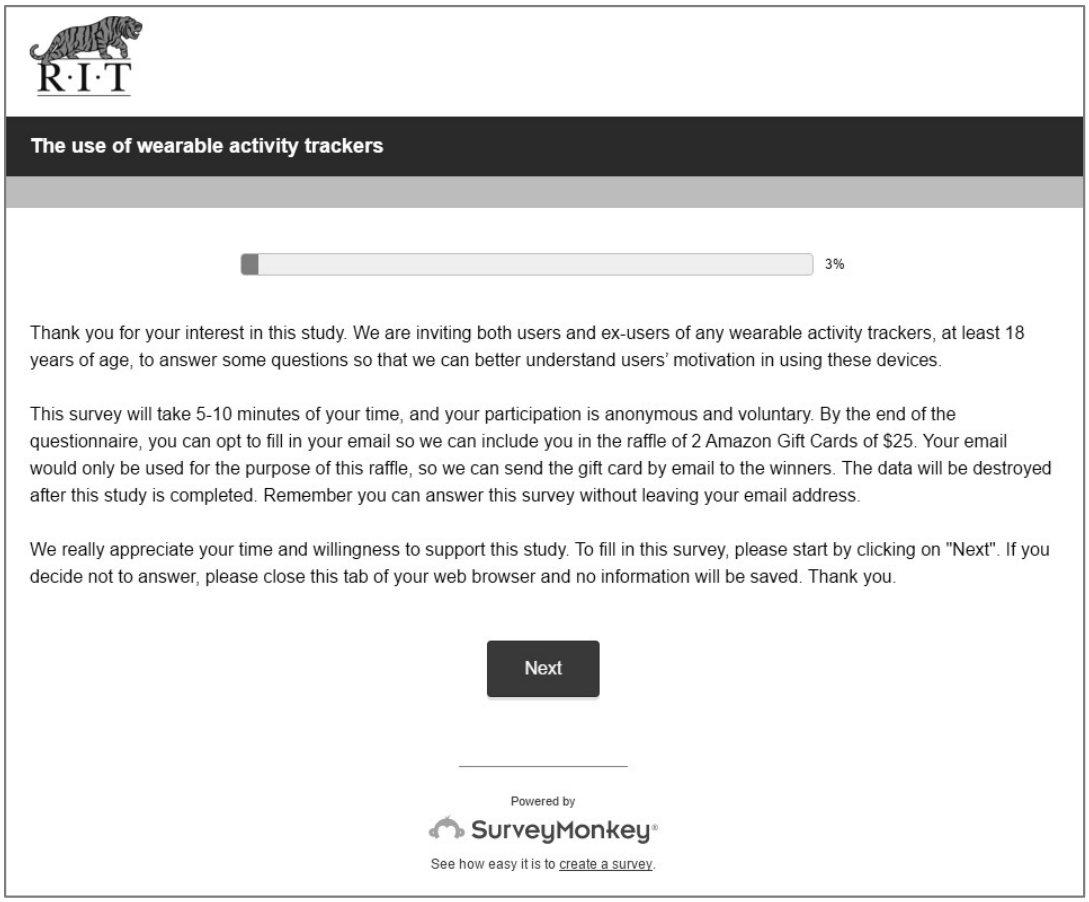
Shih, Patrick C and Han, Kyungsik and Poole, Erika Shehan and Rosson, Mary Beth and Carroll, John M. 2015. "Use and adoption challenges of wearable activity trackers." *iConference 2015 Proceedings* (iSchools).

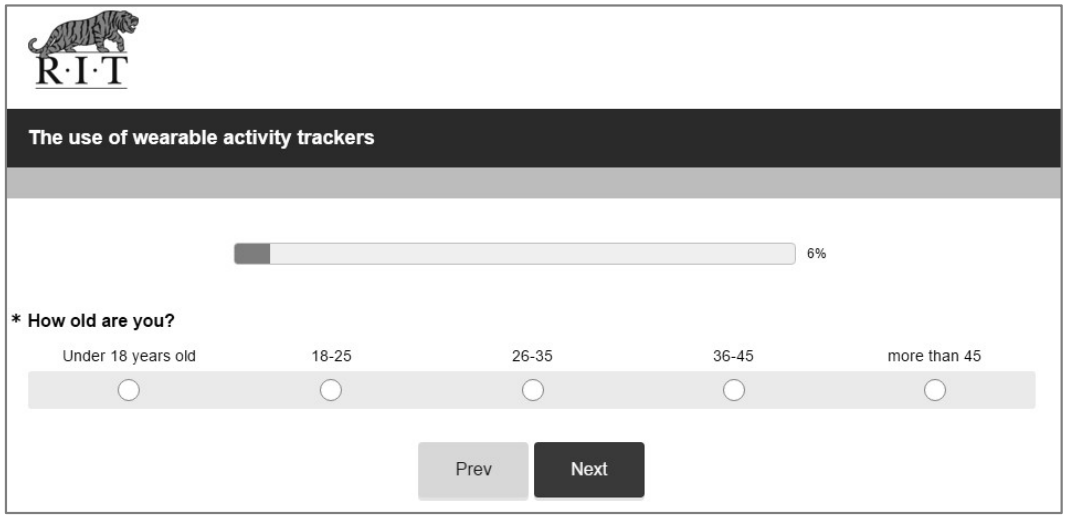
Thomas, David R. 2006. "A general inductive approach for analyzing qualitative evaluation data." *American journal of evaluation* (Sage Publications) 27 (2): 237-246.

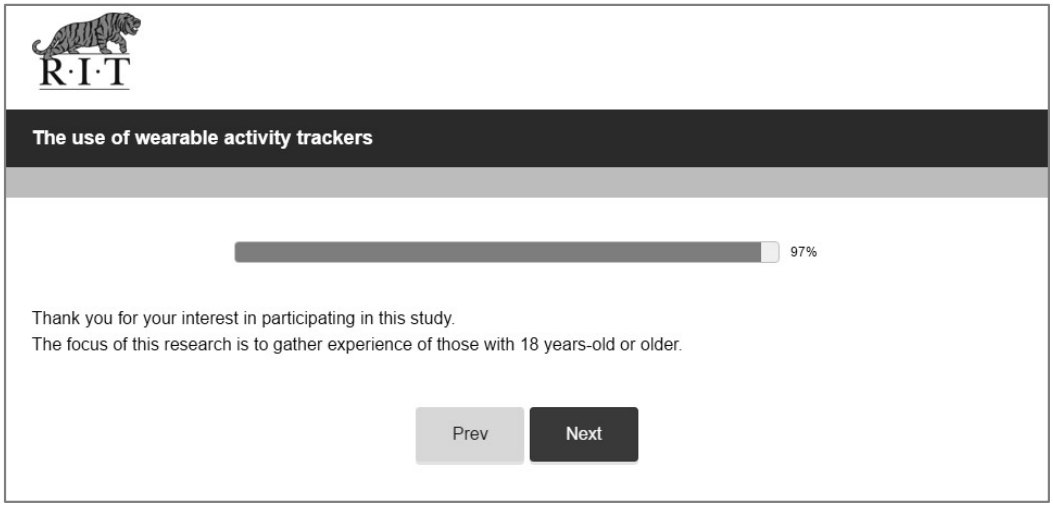
Yang, Rayoung, Eunice Shin, Mark W. Newman, and Mark S. Ackerman. 2015. "When Fitness Trackers Don'T 'Fit': End-user Difficulties in the Assessment of Personal Tracking Device Accuracy." *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing, UbiComp '15.* Osaka, Japan: ACM. 623-634. doi:10.1145/2750858.2804269.

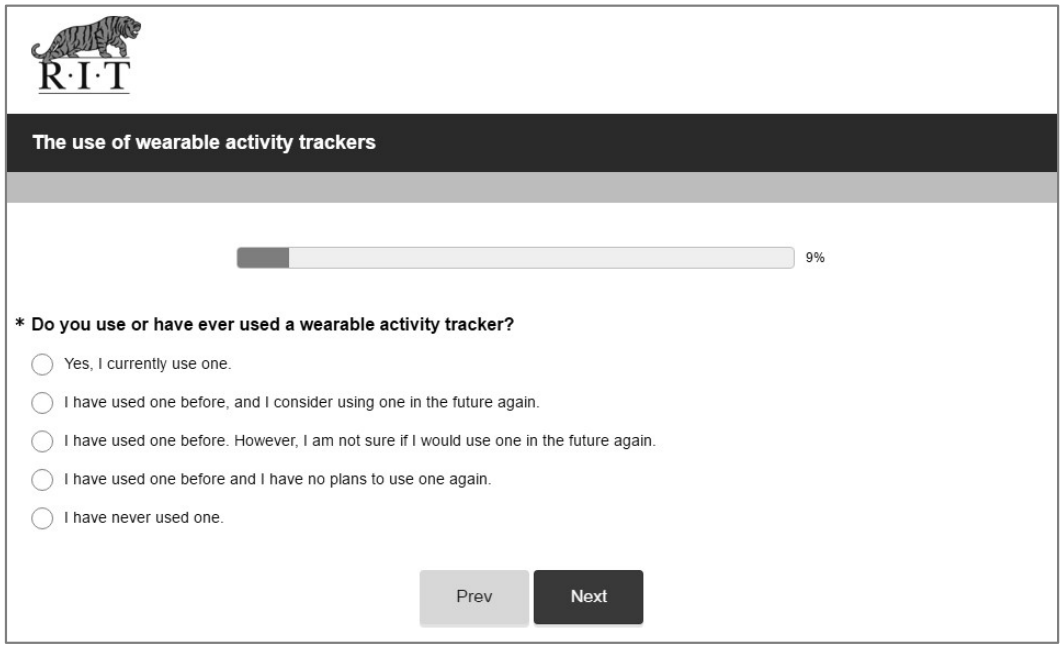
Appendix A: Online Survey

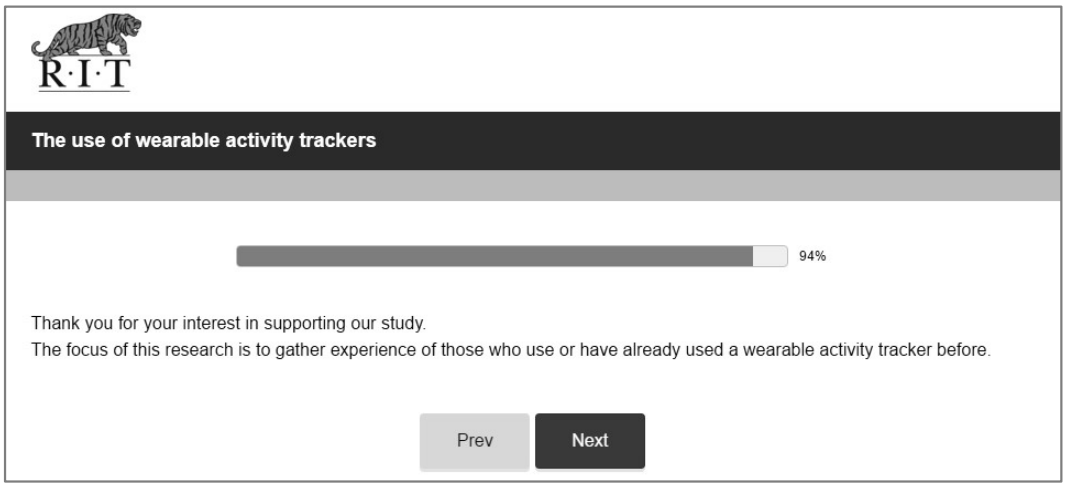
The following figures represent the survey as designed with SurveyMonkey.com.

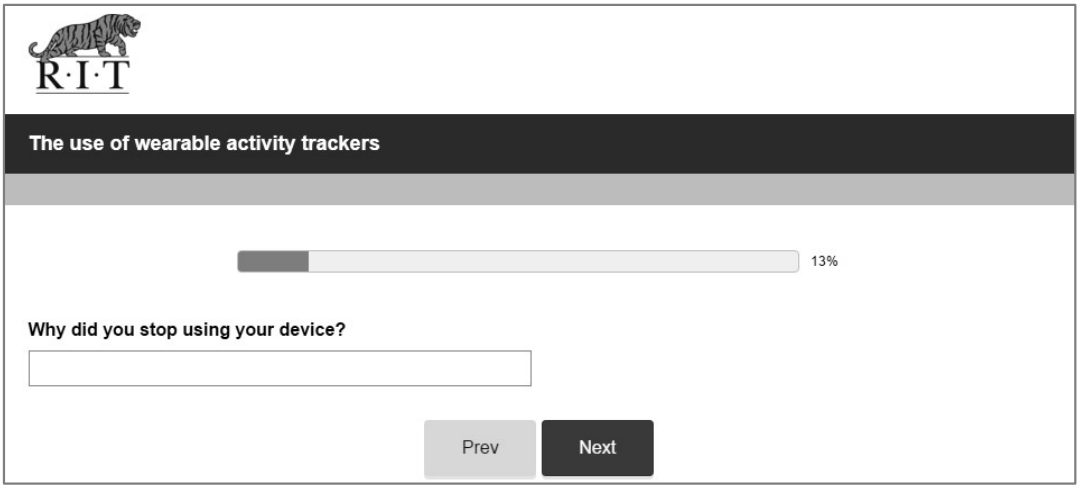


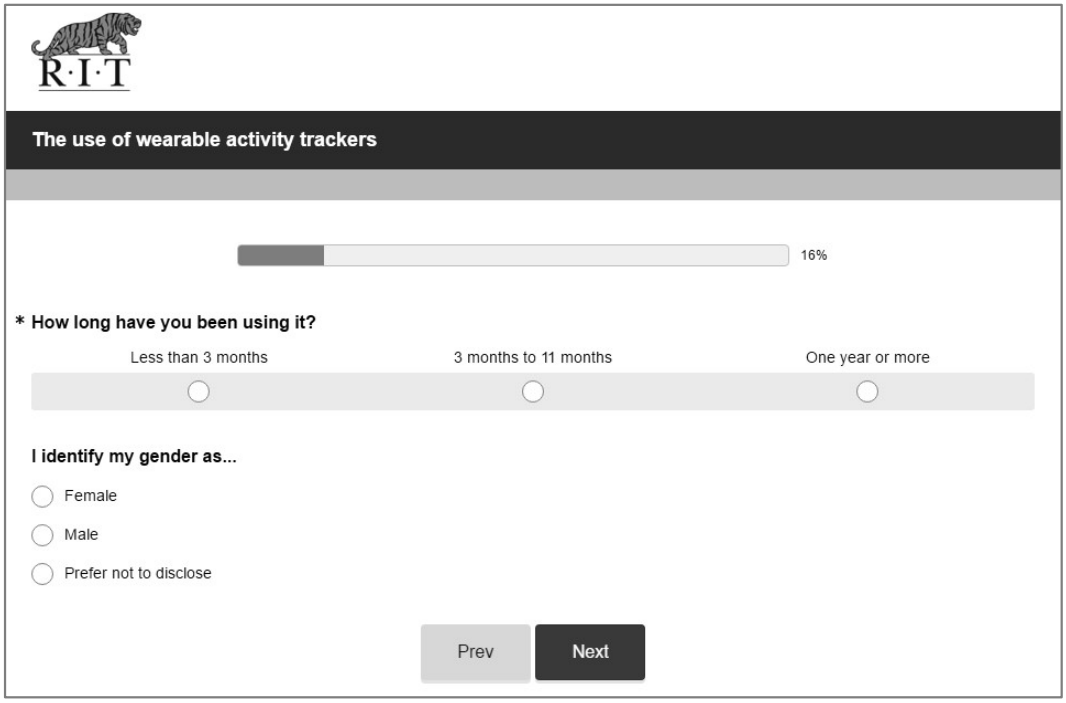


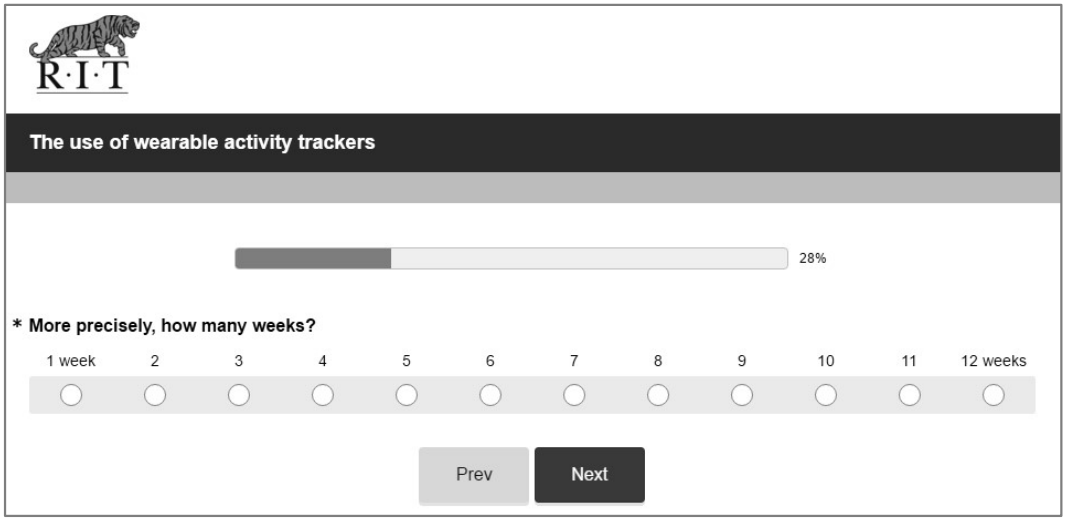

R·I·T
The use of wearable activity trackers
97%
Thank you for your interest in participating in this study.
The focus of this research is to gather experience of those with 18 years-old or older.
Prev
Next

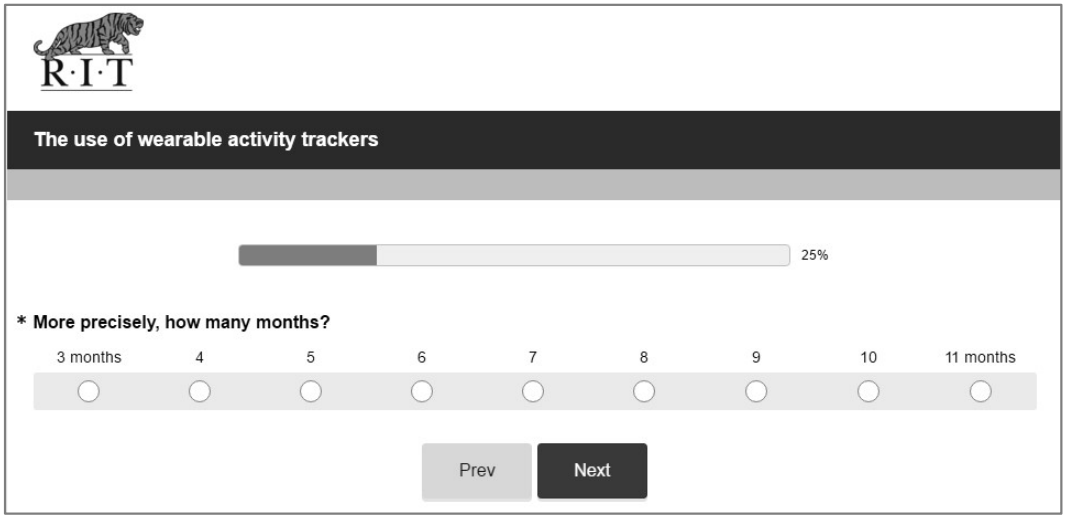

R·I·T
The use of wearable activity trackers
9%
* Do you use or have ever used a wearable activity tracker?
Yes, I currently use one.
I have used one before, and I consider using one in the future again.
I have used one before. However, I am not sure if I would use one in the future again.
I have used one before and I have no plans to use one again.
I have never used one.
Prev
Next

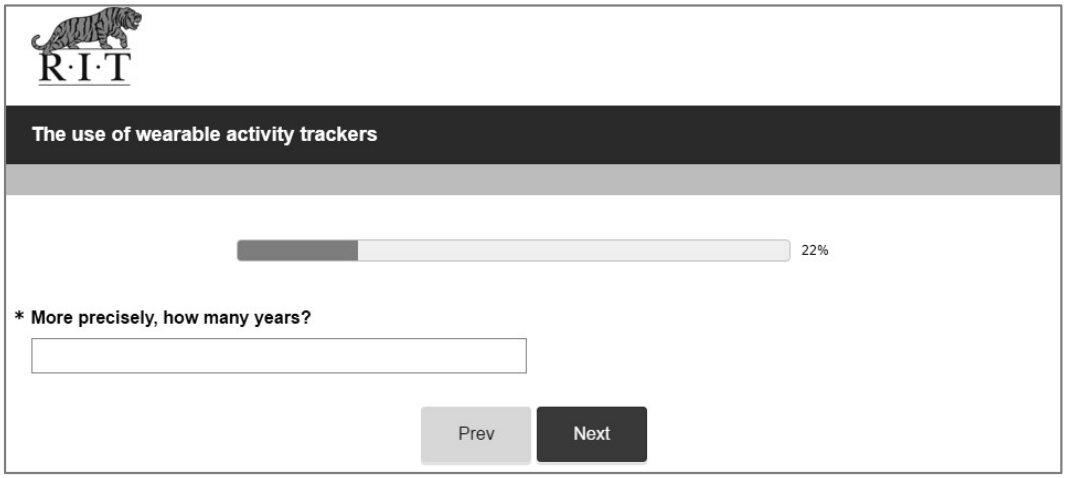

R·I·T
The use of wearable activity trackers
94%
Thank you for your interest in supporting our study.
The focus of this research is to gather experience of those who use or have already used a wearable activity tracker before.
Prev
Next

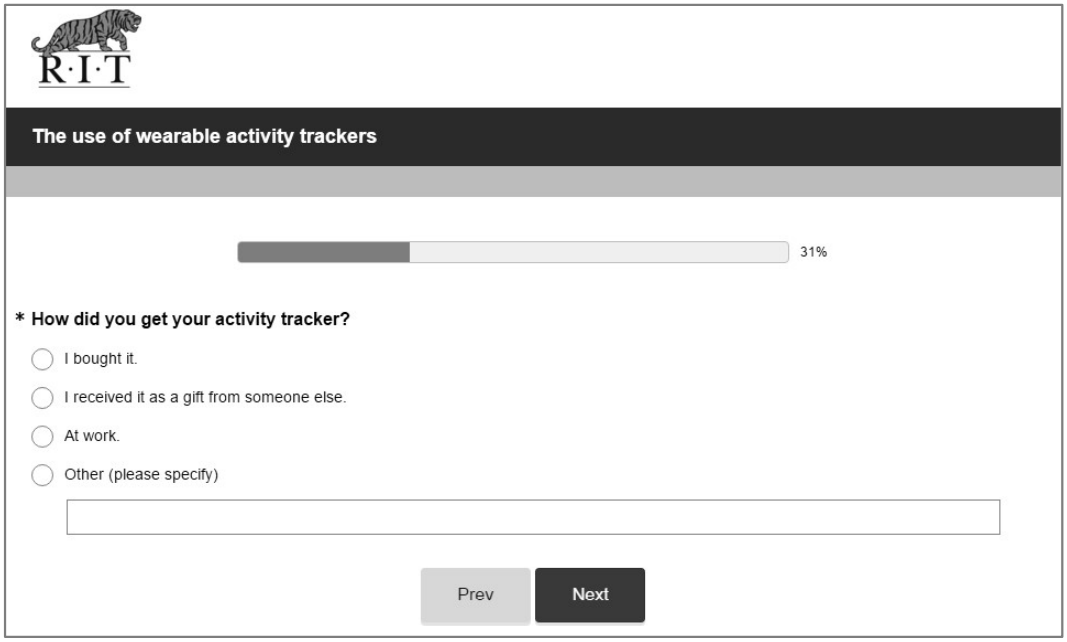

R·I·T
The use of wearable activity trackers
13%
Why did you stop using your device?
Prev
Next

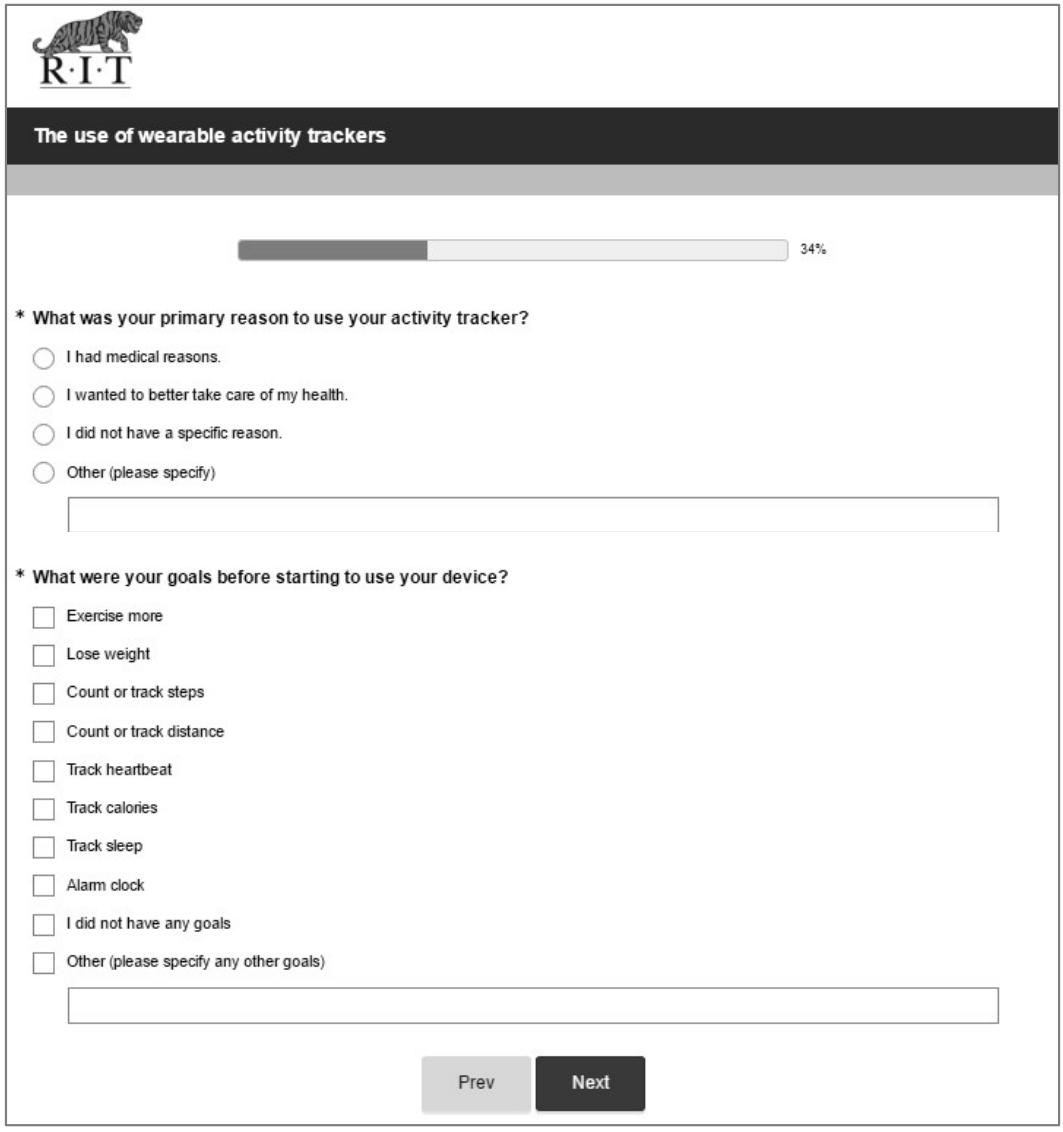

R·I·T
The use of wearable activity trackers
16%
* How long have you been using it?
Less than 3 months
3 months to 11 months
One year or more
I identify my gender as...
Female
Male
Prefer not to disclose
Prev
Next

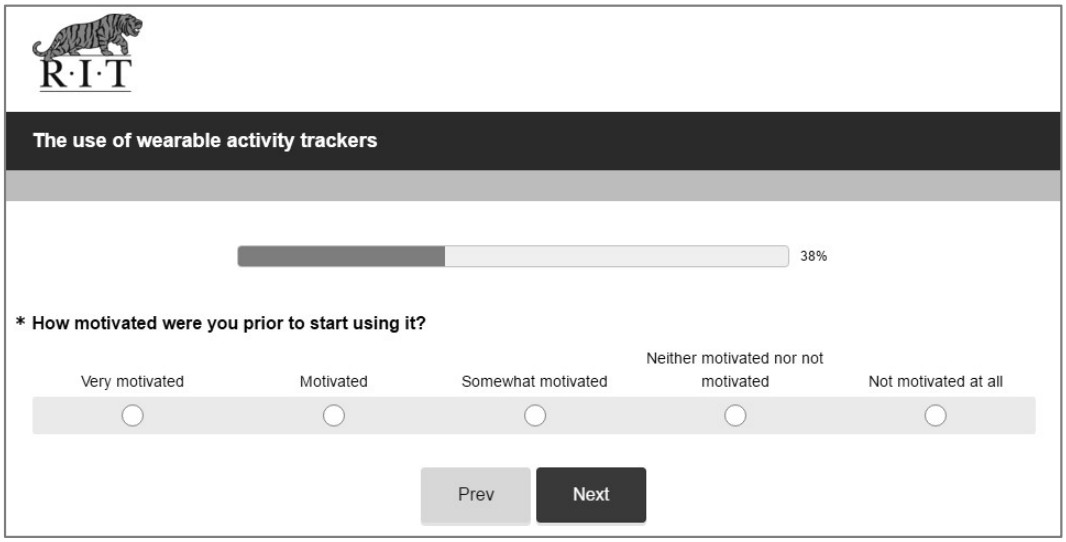

The use of wearable activity trackers
28%
* More precisely, how many weeks?
1 week 2 3 4 5 6 7 8 9 10 11 12 weeks
Prev
Next

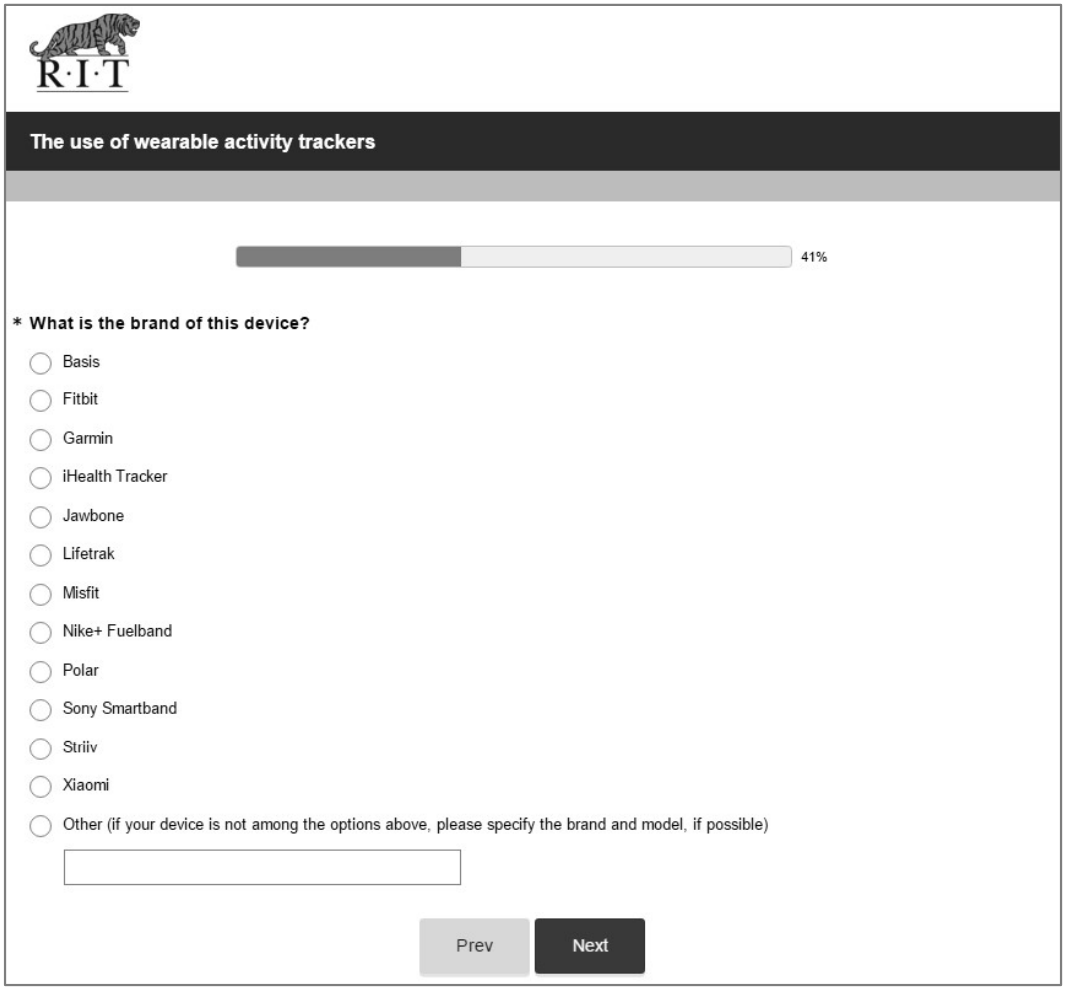

The use of wearable activity trackers
25%
* More precisely, how many months?
3 months 4 5 6 7 8 9 10 11 months
Prev
Next

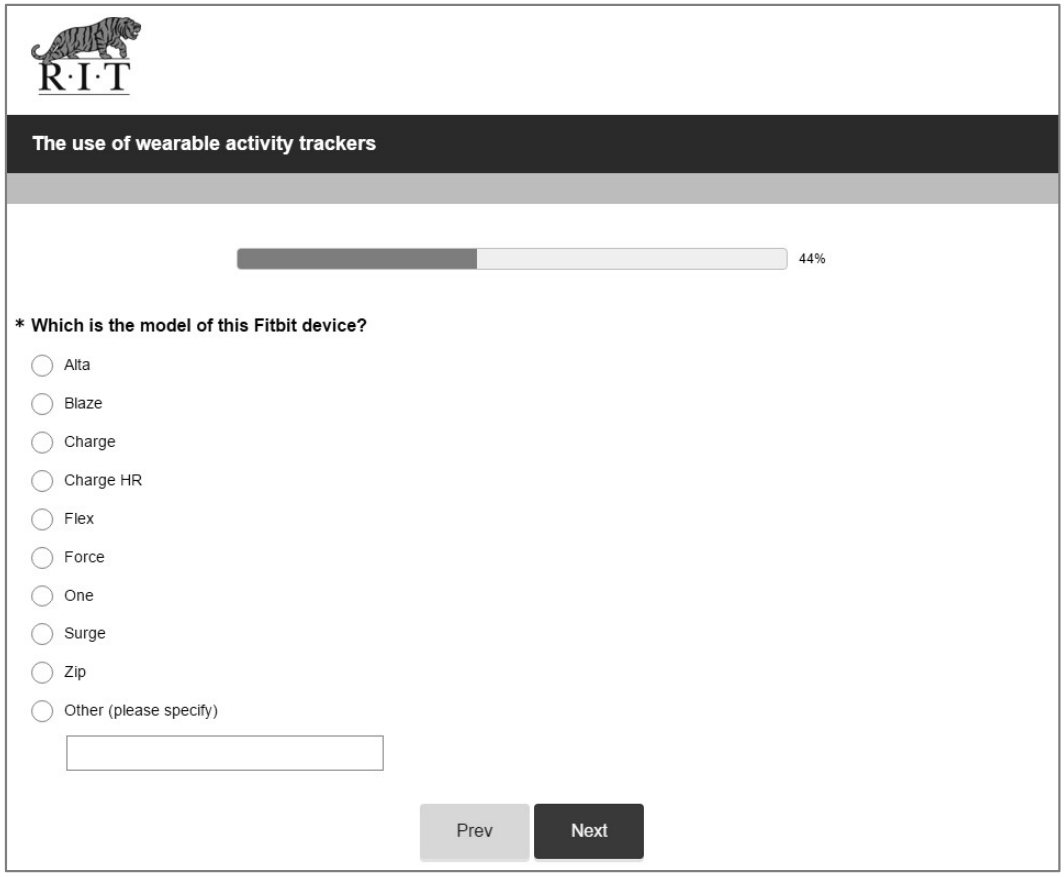

The use of wearable activity trackers
22%
* More precisely, how many years?
Prev
Next

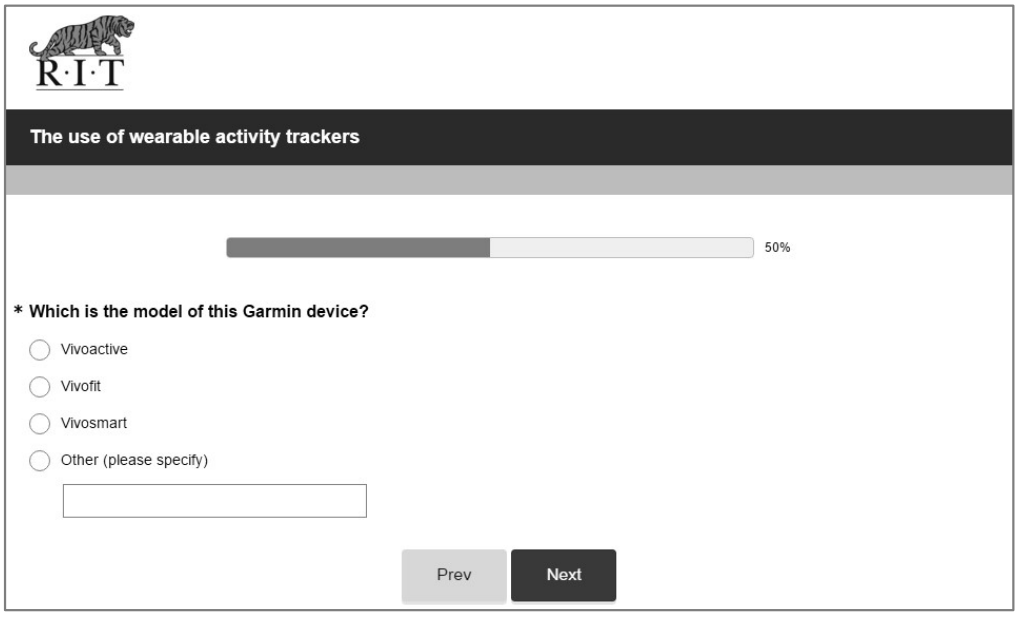

R·I·T
The use of wearable activity trackers
31%
* How did you get your activity tracker?
I bought it.
I received it as a gift from someone else.
At work.
Other (please specify)
Prev
Next

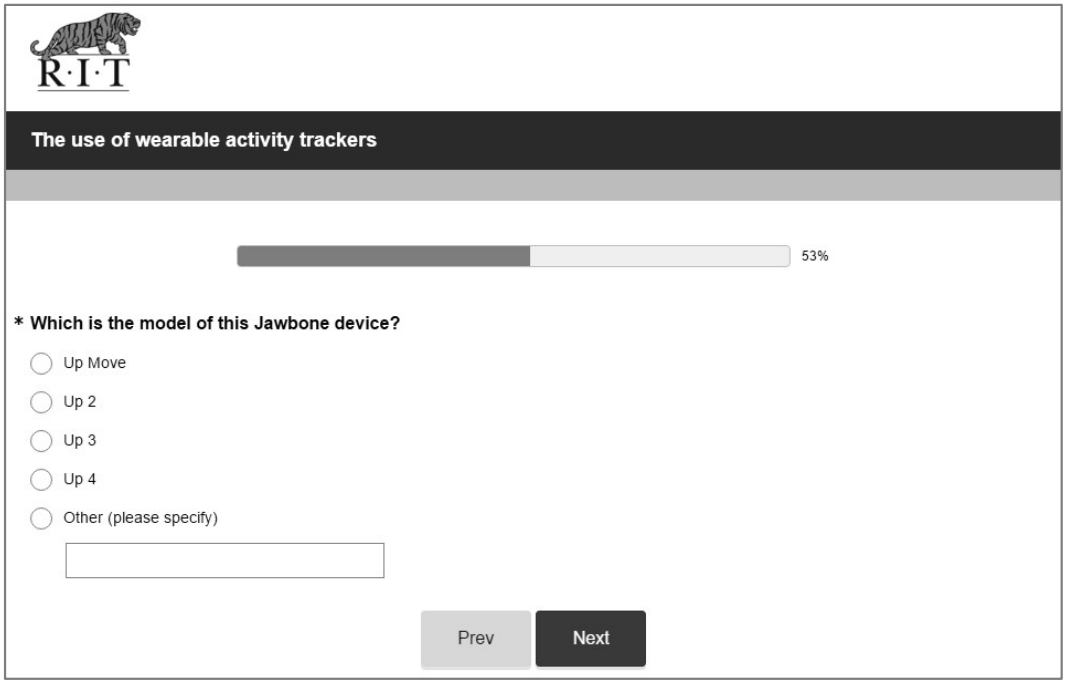

R·I·T
The use of wearable activity trackers
34%
* What was your primary reason to use your activity tracker?
I had medical reasons.
I wanted to better take care of my health.
I did not have a specific reason.
Other (please specify)
* What were your goals before starting to use your device?
Exercise more
Lose weight
Count or track steps
Count or track distance
Track heartbeat
Track calories
Track sleep
Alarm clock
I did not have any goals
Other (please specify any other goals)
Prev
Next

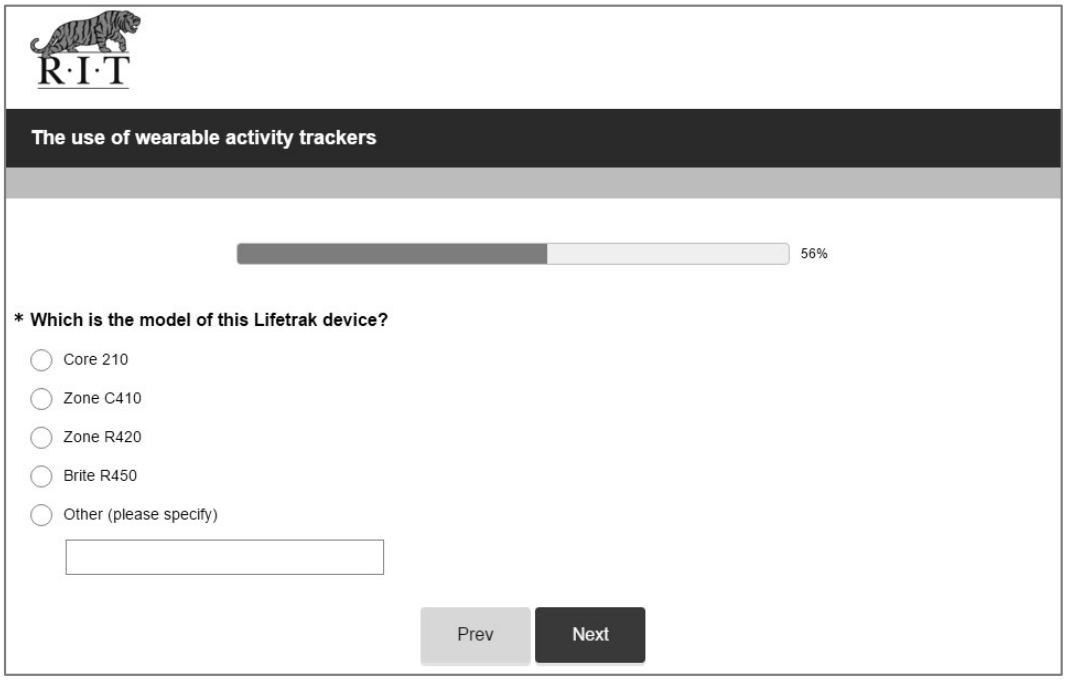

R·I·T
The use of wearable activity trackers
38%
* How motivated were you prior to start using it?
Very motivated
Motivated
Somewhat motivated
Neither motivated nor not motivated
Not motivated at all
Prev
Next

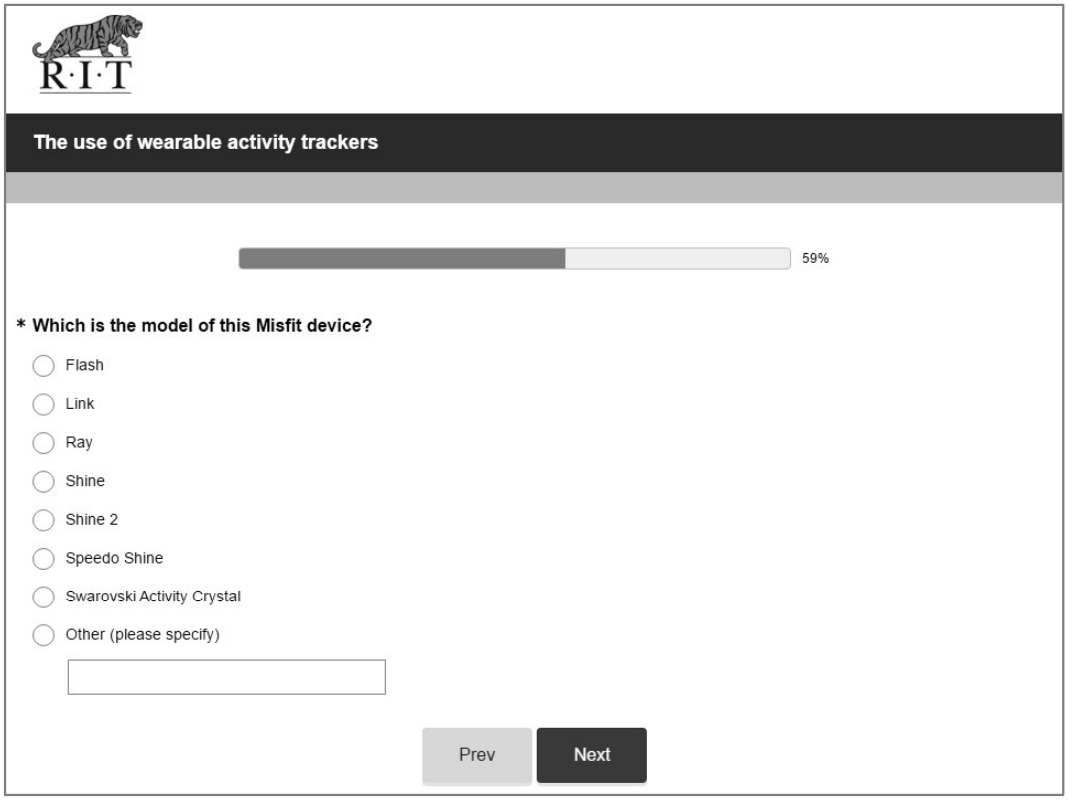

R·I·T
The use of wearable activity trackers
41%
* What is the brand of this device?
Basis
Fitbit
Garmin
iHealth Tracker
Jawbone
Lifetrak
Misfit
Nike+ Fuelband
Polar
Sony Smartband
Striiv
Xiaomi
Other (if your device is not among the options above, please specify the brand and model, if possible)
Prev
Next

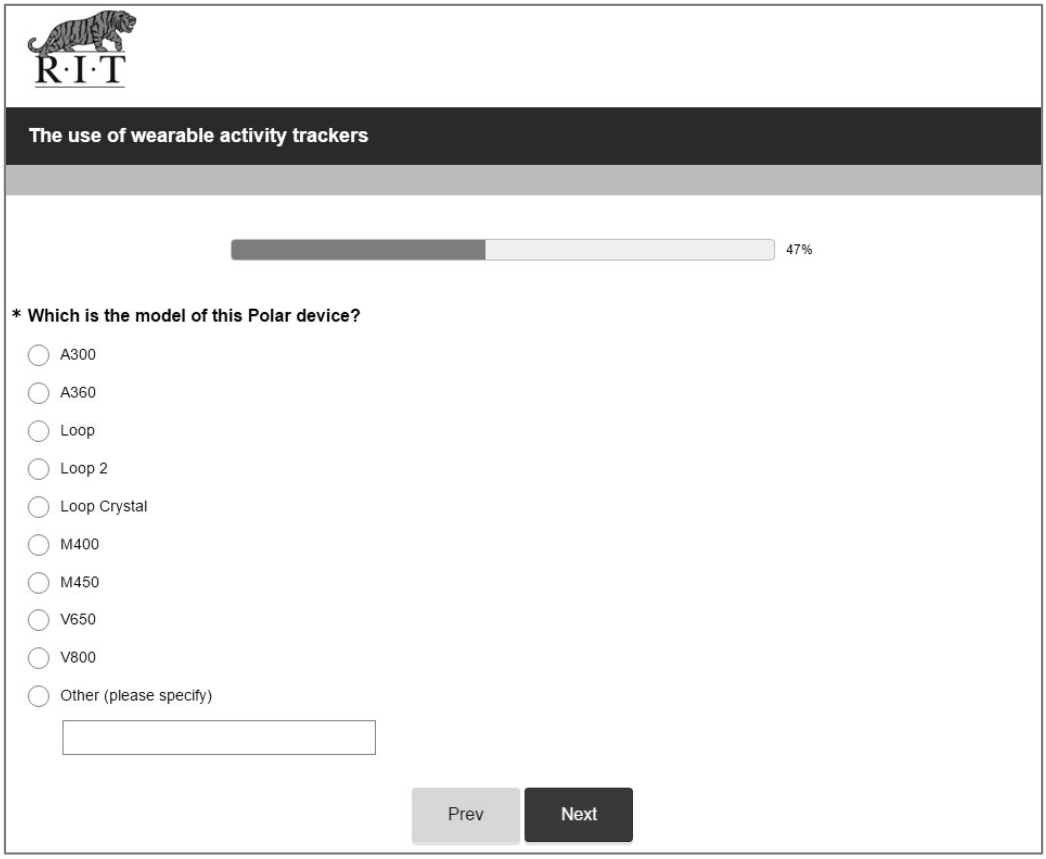

R·I·T
The use of wearable activity trackers
44%
* Which is the model of this Fitbit device?
Alta
Blaze
Charge
Charge HR
Flex
Force
One
Surge
Zip
Other (please specify)
Prev
Next

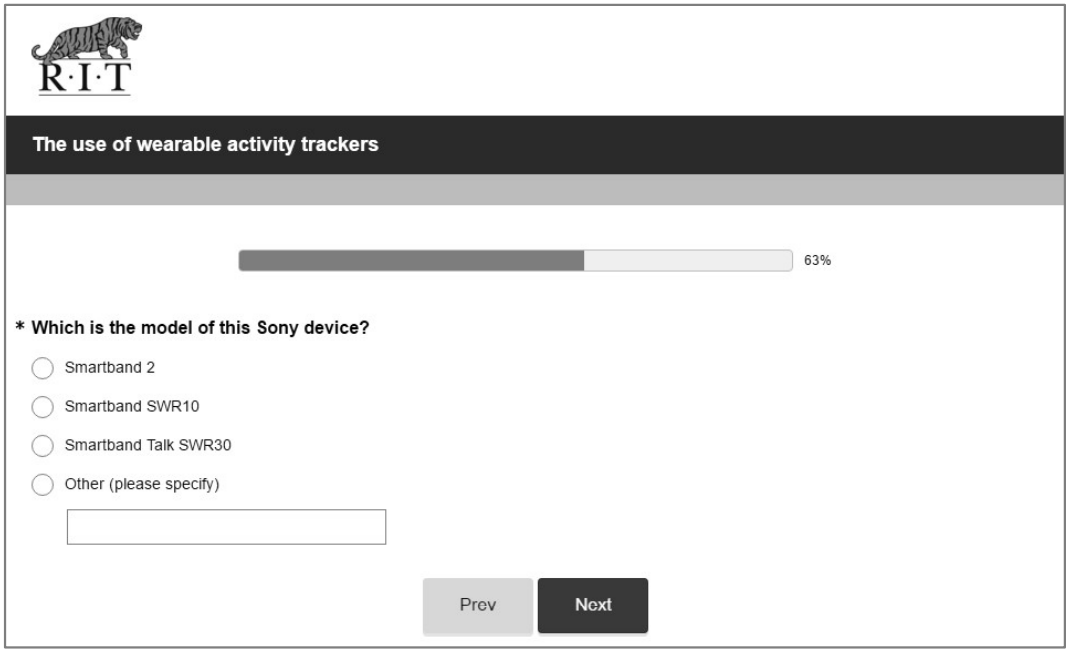

R·I·T
The use of wearable activity trackers
50%
* Which is the model of this Garmin device?
Vivoactive
Vivofit
Vivosmart
Other (please specify)
Prev
Next

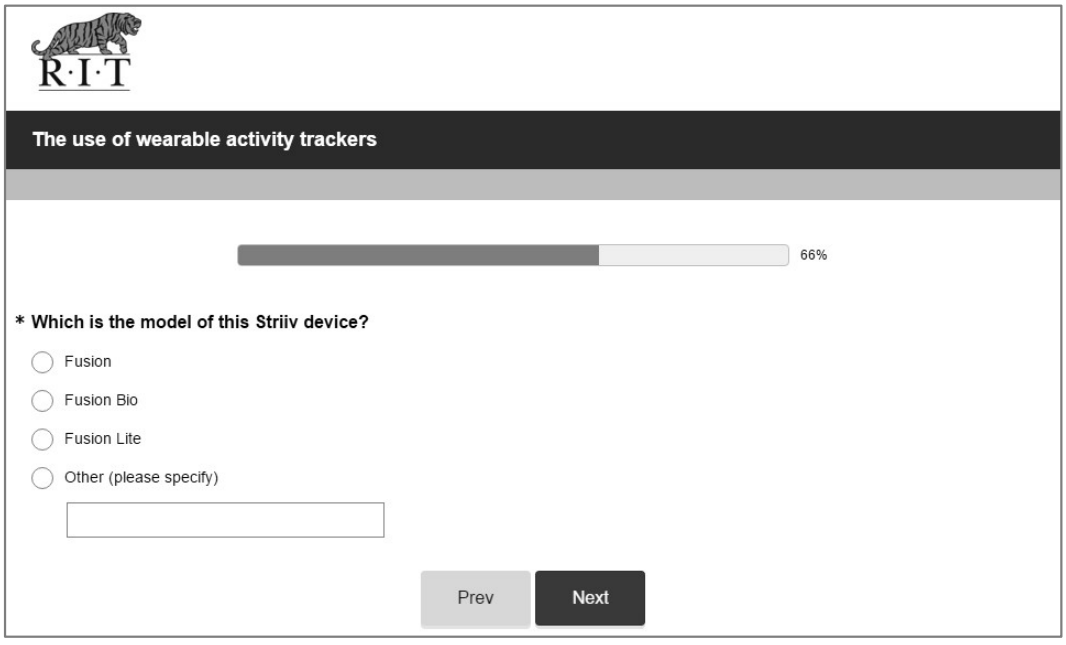

The use of wearable activity trackers
53%
* Which is the model of this Jawbone device?
Up Move
Up 2
Up 3
Up 4
Other (please specify)
Prev
Next

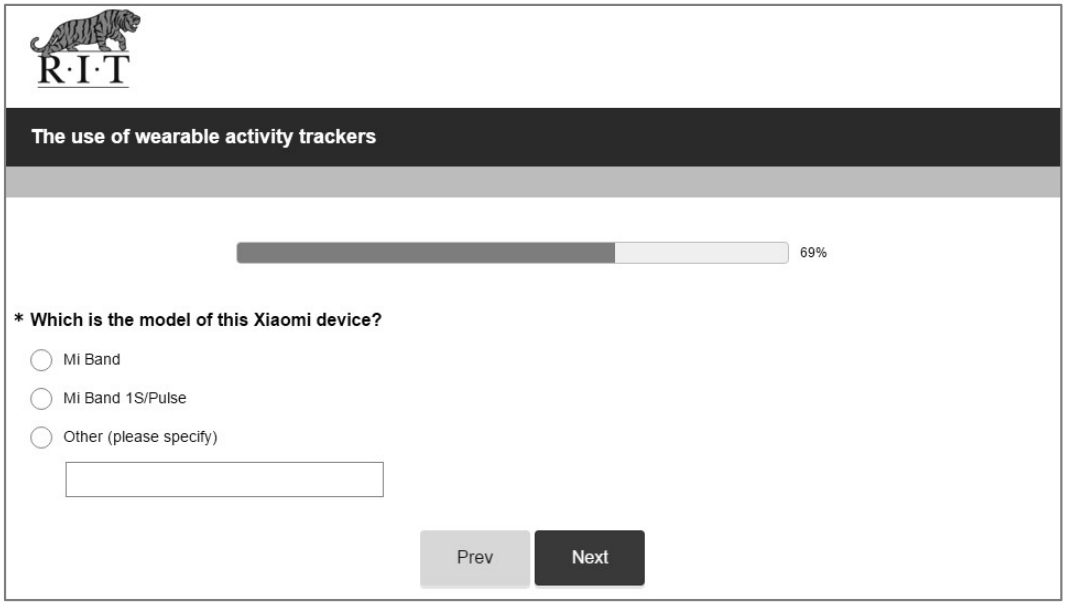

The use of wearable activity trackers
56%
* Which is the model of this Lifetrak device?
Core 210
Zone C410
Zone R420
Brite R450
Other (please specify)
Prev
Next

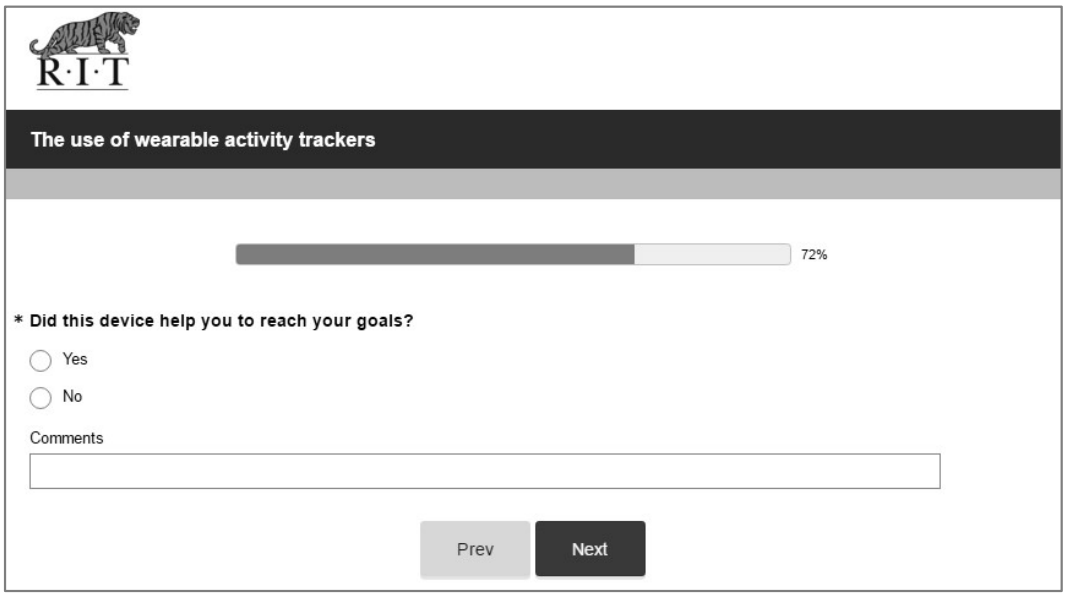

R·I·T
The use of wearable activity trackers
59%
* Which is the model of this Misfit device?
Flash
Link
Ray
Shine
Shine 2
Speedo Shine
Swarovski Activity Crystal
Other (please specify)
Prev
Next

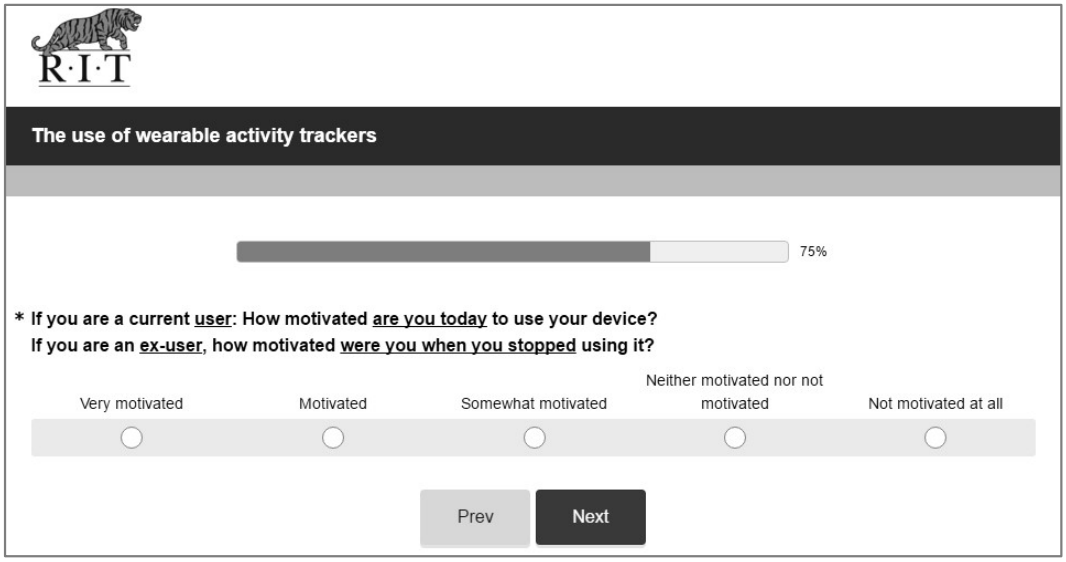

R·I·T
The use of wearable activity trackers
47%
* Which is the model of this Polar device?
A300
A360
Loop
Loop 2
Loop Crystal
M400
M450
V650
V800
Other (please specify)
Prev
Next

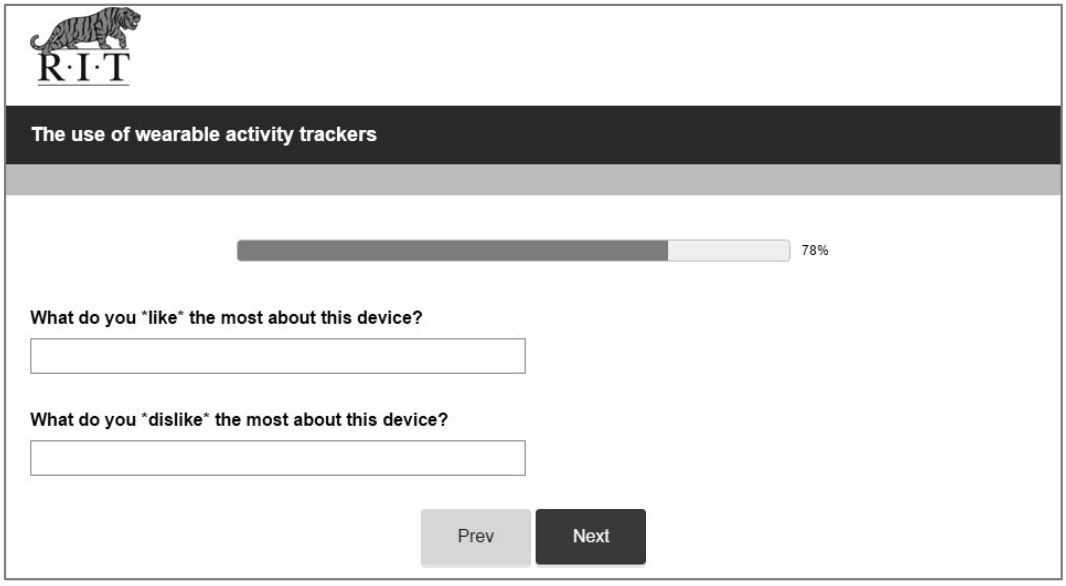

R·I·T
The use of wearable activity trackers
63%
* Which is the model of this Sony device?
Smartband 2
Smartband SWR10
Smartband Talk SWR30
Other (please specify)
Prev
Next

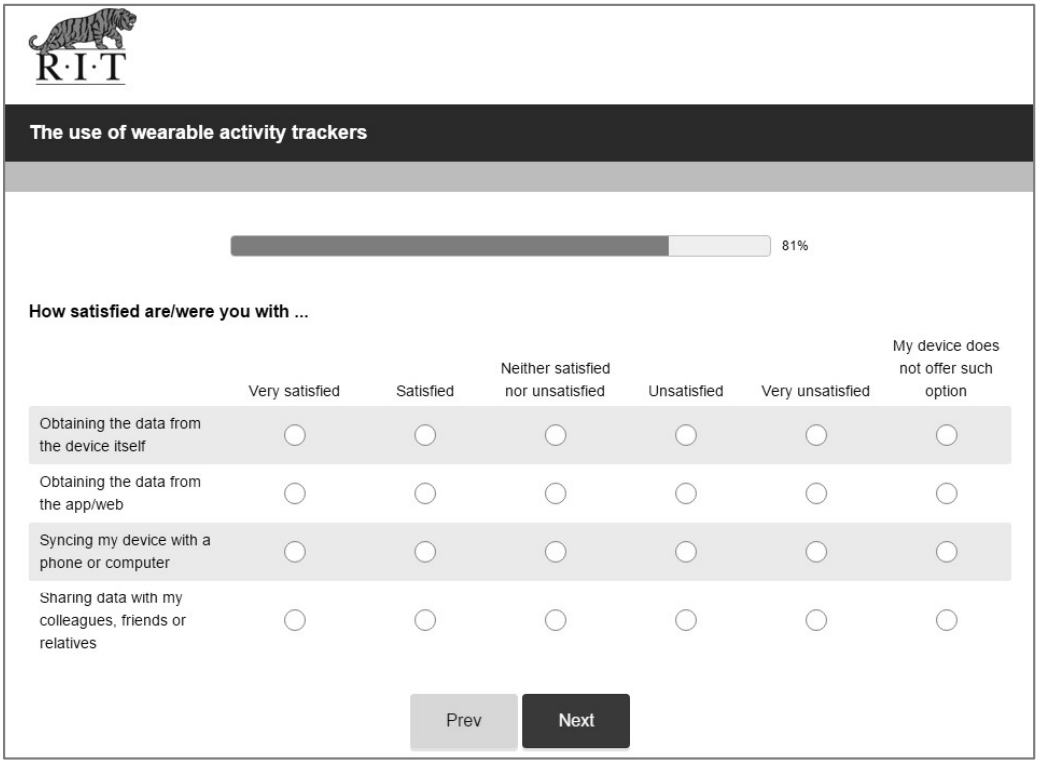

R·I·T
The use of wearable activity trackers
66%
* Which is the model of this Striiv device?
Fusion
Fusion Bio
Fusion Lite
Other (please specify)
Prev
Next

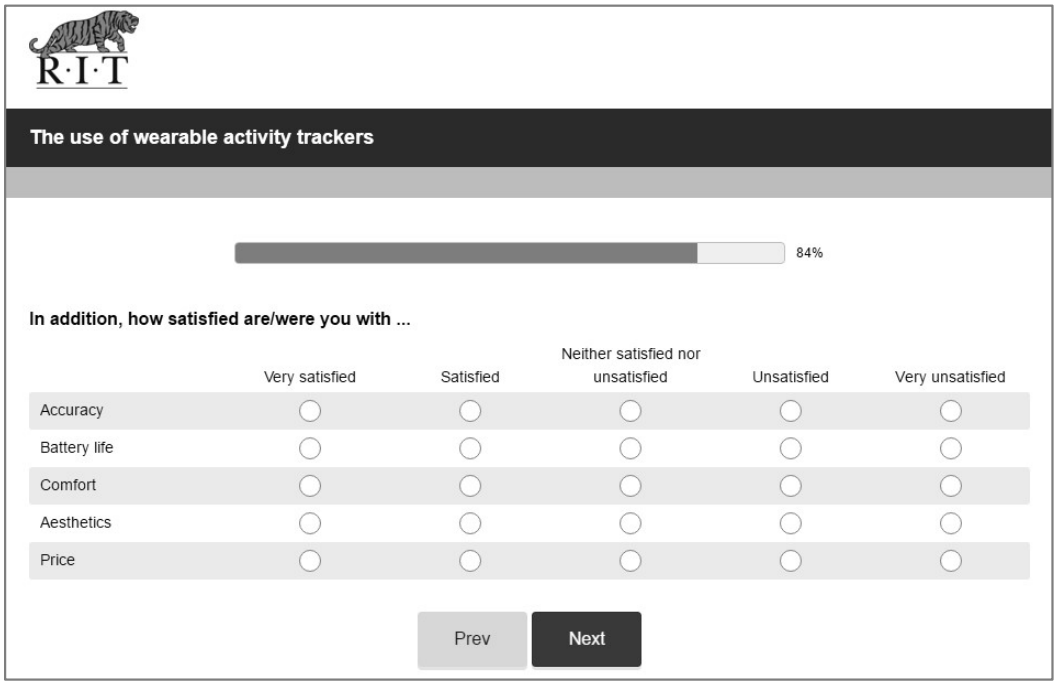

The use of wearable activity trackers
69%
* Which is the model of this Xiaomi device?
Mi Band
Mi Band 1S/Pulse
Other (please specify)
Prev
Next

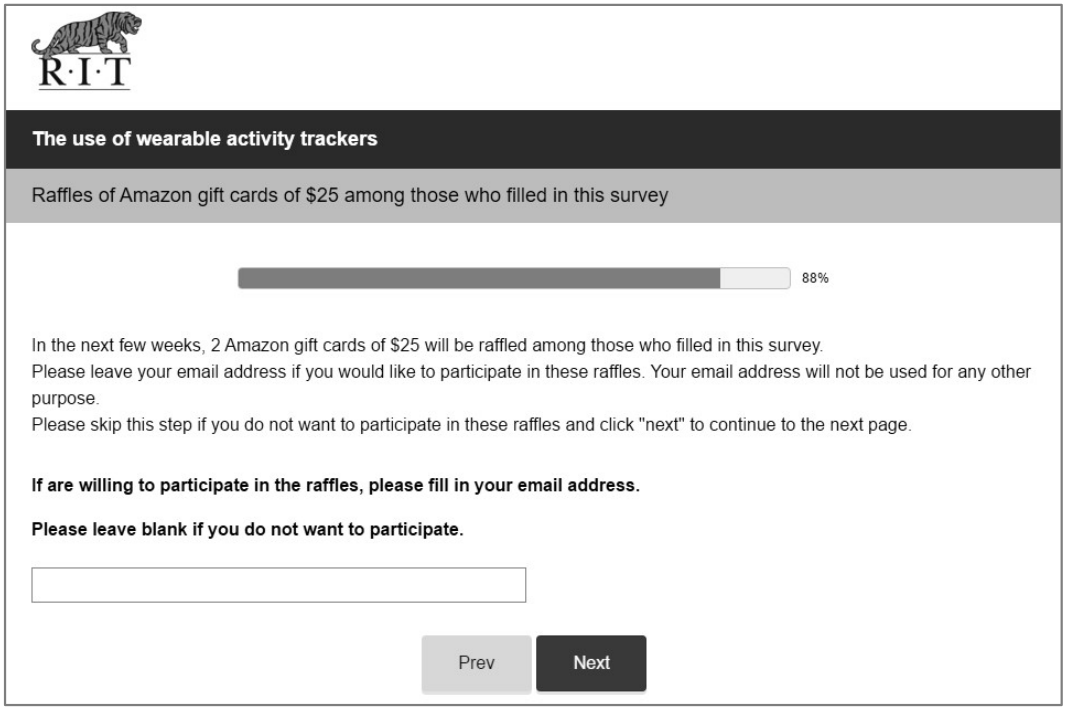

The use of wearable activity trackers
72%
* Did this device help you to reach your goals?
Yes
No
Comments
Prev
Next

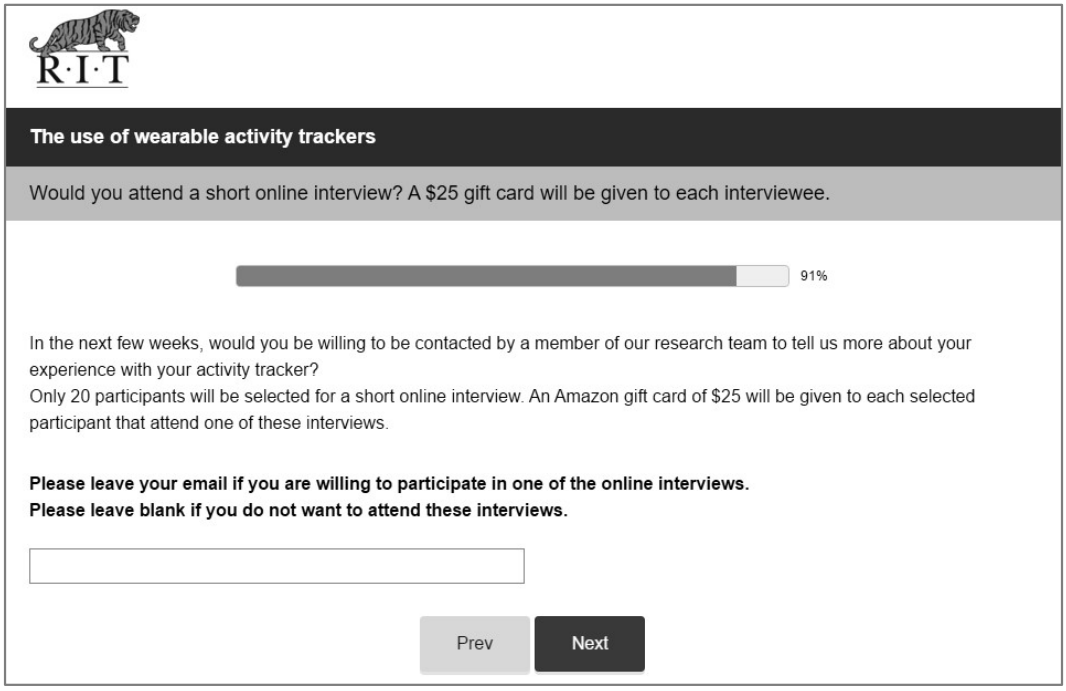

R·I·T
The use of wearable activity trackers
75%
* If you are a current user: How motivated are you today to use your device?
If you are an ex-user, how motivated were you when you stopped using it?
Very motivated
Motivated
Somewhat motivated
Neither motivated nor not motivated
Not motivated at all
Prev
Next

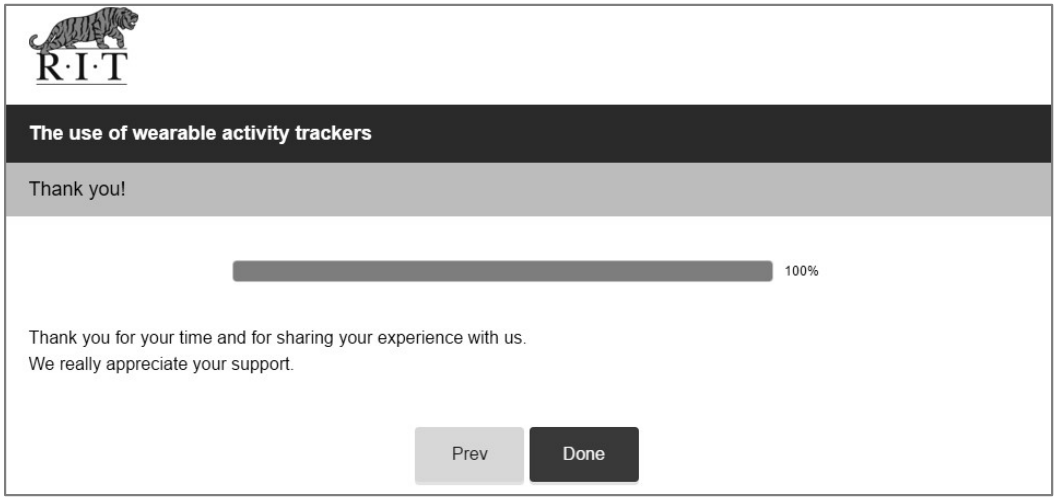

R·I·T
The use of wearable activity trackers
78%
What do you *like* the most about this device?
What do you *dislike* the most about this device?
Prev
Next


The use of wearable activity trackers
81%
How satisfied are/were you with ...
Very satisfied
Satisfied
Neither satisfied nor unsatisfied
Unsatisfied
Very unsatisfied
My device does not offer such option
Obtaining the data from the device itself
Obtaining the data from the app/web
Syncing my device with a phone or computer
Sharing data with my colleagues, friends or relatives
Prev
Next


The use of wearable activity trackers
84%
In addition, how satisfied are/were you with ...
Very satisfied
Satisfied
Neither satisfied nor unsatisfied
Unsatisfied
Very unsatisfied
Accuracy
Battery life
Comfort
Aesthetics
Price
Prev
Next

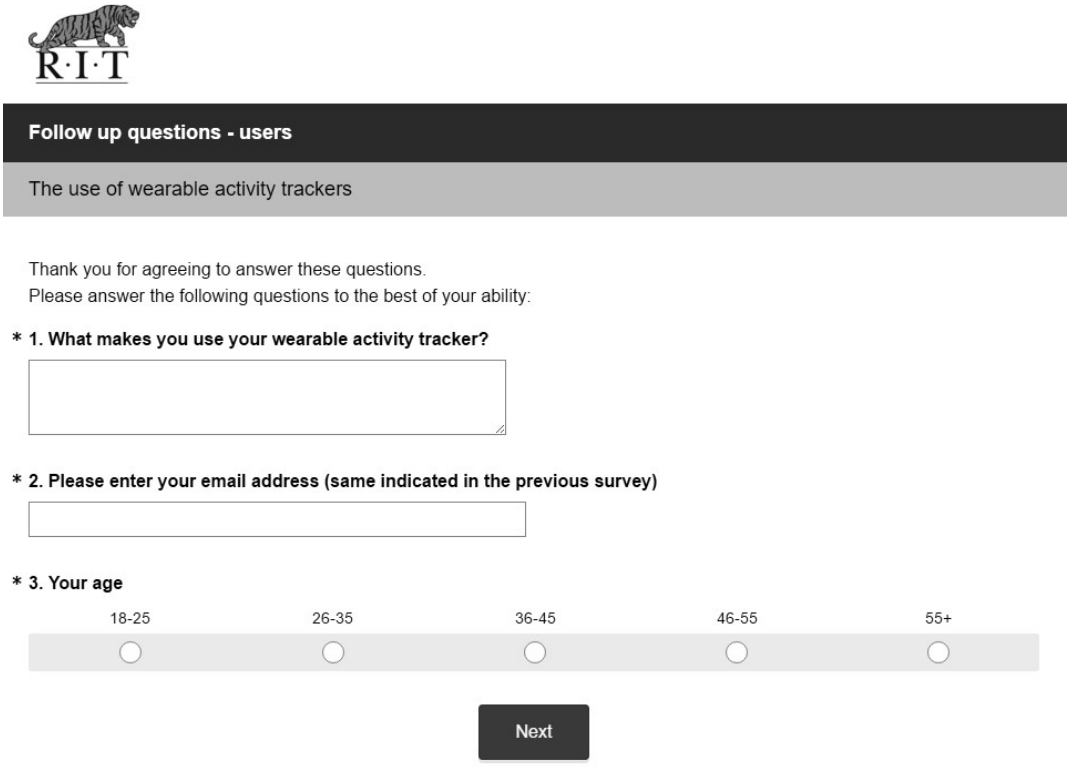

R·I·T
The use of wearable activity trackers
Raffles of Amazon gift cards of $25 among those who filled in this survey
88%
In the next few weeks, 2 Amazon gift cards of $25 will be raffled among those who filled in this survey.
Please leave your email address if you would like to participate in these raffles. Your email address will not be used for any other purpose.
Please skip this step if you do not want to participate in these raffles and click "next" to continue to the next page.
If are willing to participate in the raffles, please fill in your email address.
Please leave blank if you do not want to participate.
Prev
Next


R·I·T
The use of wearable activity trackers
Would you attend a short online interview? A $25 gift card will be given to each interviewee.
91%
In the next few weeks, would you be willing to be contacted by a member of our research team to tell us more about your experience with your activity tracker?
Only 20 participants will be selected for a short online interview. An Amazon gift card of $25 will be given to each selected participant that attend one of these interviews.
Please leave your email if you are willing to participate in one of the online interviews.
Please leave blank if you do not want to attend these interviews.
Prev
Next


R·I·T
The use of wearable activity trackers
Thank you!
100%
Thank you for your time and for sharing your experience with us.
We really appreciate your support.
Prev
Done

Appendix B: Complementary Survey – Current Users

The following images represent the complete complementary survey sent to 266 email addresses from participants who declared to be current users of activity trackers and that left their email addresses for the raffle of gift cards or to attend an online interview.



Follow up questions - users

The use of wearable activity trackers

Thank you for agreeing to answer these questions.
Please answer the following questions to the best of your ability:

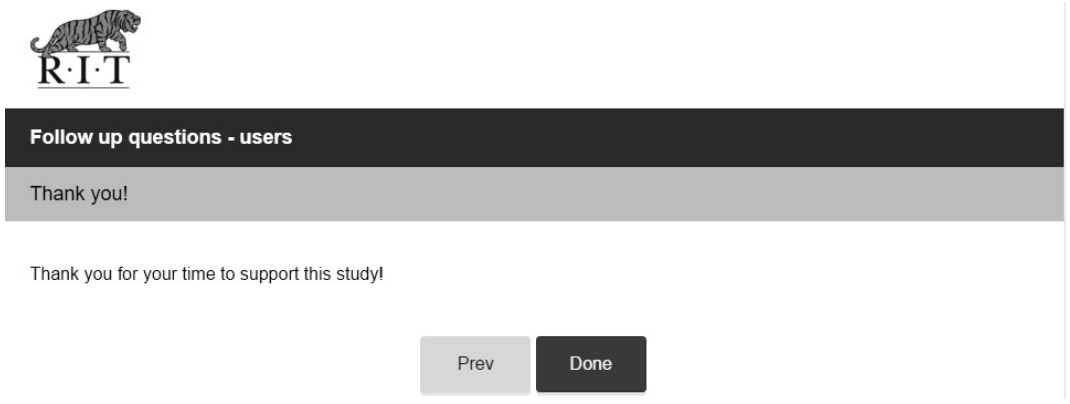
*** 1. What makes you use your wearable activity tracker?**

*** 2. Please enter your email address (same indicated in the previous survey)**

*** 3. Your age**

18-25 | 26-35 | 36-45 | 46-55 | 55+

Next



Follow up questions - users

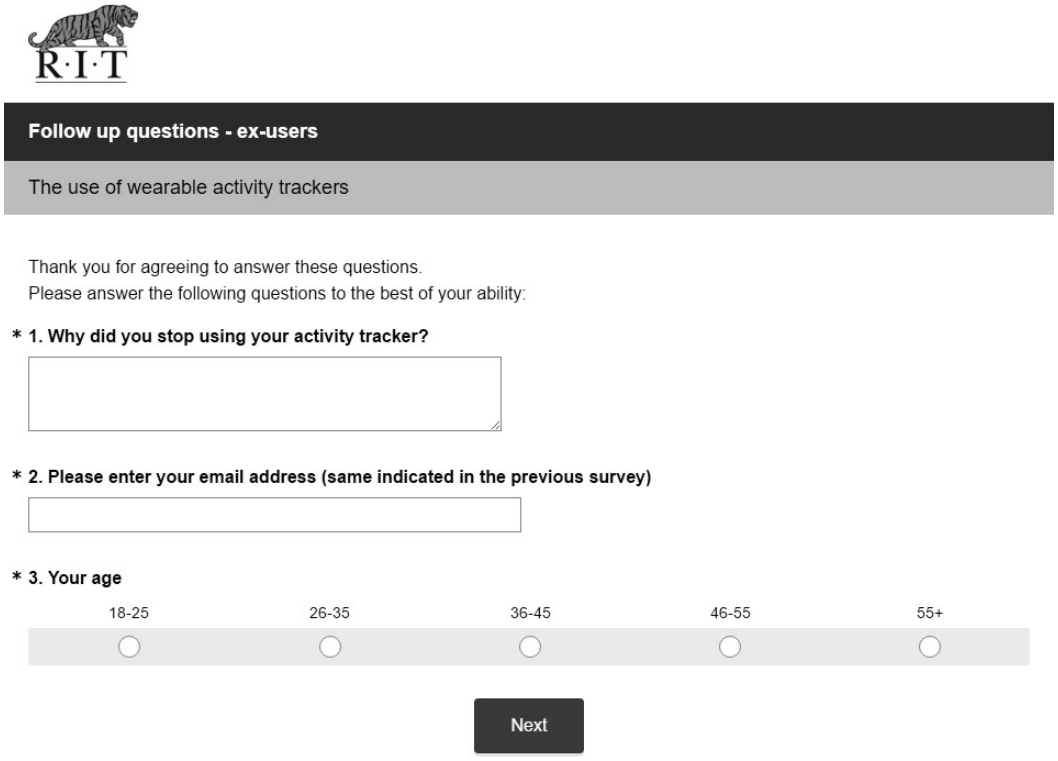
Thank you!

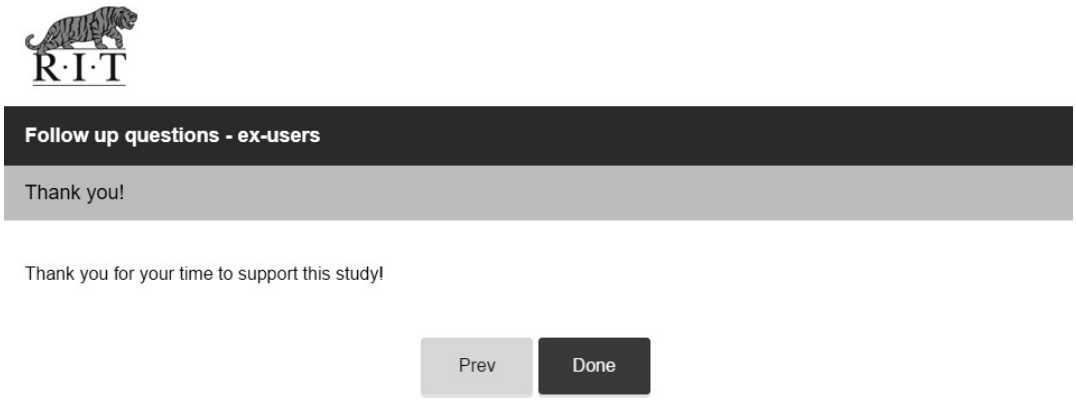
Thank you for your time to support this study!

Prev | Done

Appendix C: Complementary Survey – Ex-Users

The following images represent the complete complementary survey which was sent to 5 email addresses from participants who did not answer the question "Why did you stop using your activity tracker" in the main survey.





Appendix D: Interview Questions

The following set of questions guided the interviews with ex-users and current users; differences between start by question number 10.

1) Why did you decide to get your activity tracker?
2) How did you choose your model?
3) How often did you use to wear it?
4) Did your device help to reach your goals? If so, how the activity tracker influenced your achievements?
5) [Check easy/difficult with]:
    a) device's interface, if any,
    b) device's app in the smartphone or website,
    c) syncing mechanism (manual, automatic),
    d) battery life,
    e) comfort,
    f) aesthetics;
6) Do you use to share your data with friends? Through the app or social media?
7) Did you perceive changes in your daily life along time after start using it?
8) Were there times you decided or forget to wear it? How was this experience?
9) How your goals are set and how do you feel when you don't reach them?

The following questions were only considered for the ex-users group:

10) Why did you stop using your device?
11) Do you consider using an activity tracker again? If so, why and which model would you consider?

The next questions were made for the participants that were currently using their activity trackers:

10) Were there occasions in which you did not use your device?

(if so, explore: how long, why, and how was this experience without the device)

11) How long do you intend to use it?

12) Do you consider replacing or model for another?

(if so, why, which would be this new model).

Appendix E: History of Posts in Social Media

This appendix shows in details the history of posts on social media and other actions to gather participation for the online survey. The potential reasons for the daily survey responses rate, related hashtags and name of the online communities considered are also included.

Date (2016)	Survey participation	Responses due to	Social media	Post characteristics and comments
Mar 1st	14	This day's posts.	Facebook, *alessandra.david.524*	The invitation was posted with the hashtags: #RIT, #activitytracker, # activitytrackers, #fitnesstracker, #smartwear, #wearables, #wearabletech. Three Facebook friends shared this post.
			Twitter, @aledavid	The invitation to participate was posted using the hashtags: #wearables, #activitytrackers
Mar 2nd	7	Most likely due the actions on the previous day.	Facebook	One Facebook post share
			Twitter, @aledavid	Post content: *[@company_account]* *Our research is seeking users/ex-users of wearable activity trackers. 10-min survey w/ raffles of gift cards. http://goo.gl/3eenOa* The "@company_account" in brackets above was replaced by: @Fitbit, @Garmin, @GarminUK, @iHealthLabsEU, @Jawbone, @MyLifeTrak, @Misfit, @NikeFuel, @PolarGlobal, @Striiv, @Xiaomi, and @XiaomiMiBand. No Twitter account was found for the Sony Smartband.
Mar 3rd	6	Most likely these survey answers are due the actions on Mar 1st, as well	Facebook	One Facebook user shared the message posted on Mar 1st.
			Twitter, @aledavid	6 messages were posted as in the example below: *Research is seeking for users/ex-users of any wearable activity tracker. 10-min survey:*

Date (2016)	Survey participation	Responses due to	Social media	Post characteristics and comments
		as Twits and email on Mar 3rd		http://goo.gl/3eenOa *[#brand_hashtags]* "#brand_hashtags" in the brackets above was replaced by up to 3 of the following hashtags, due to the 140-character limit in Twitter: #Fitbit, #Garmin, #iHealth, #Jawbone, #Lifetrak, #Misfit, #NikeFuelBand, #Polar, #Striiv, #SonySmartband, #SonyLifelog, #BasisPeak, #myBasis.
			Twitter, From a Twitter user account	Re-twit; this Twitter user voluntarily added the following hashtags in their post: #fitness #research #usability.
			Email, ard6573@rit.edu	Email sent to 11 classmates the investigator has studied with in the Human-Computer Interaction and Experimental Psychology graduate programs.
Mar 4th - 5th	1	Actions until Mar 3rd	N/A	No messages were posted. Due to low number of responses accumulated (26), a selection of communities in Facebook was started for further posts.
Mar 6th	2	Actions until Mar 3rd	Facebook, *alessandra.david.524*	This users account asked to join the following communities: *Fitbit simple steppers*: authorization requested; invitation to participate was posted and deleted on the same day. *Garmin Vivosmart/Fit Gathering place*: authorization requested; probably not approved, since no message of approval was received; *Misfit Shiners,* *Jawbone UP-pers Unite,* *Fitbit for 50+:* Authorization requested and approved.
Mar 7th	1	Actions until Mar 3rd	Google+, ard6573@rit.edu	The same message posted on Mar 1st at Facebook was posted in the following groups at Google+: *Fitness Activity Trackers,* *Jawbone UP,* *Jawbone UP3,* *Misfit Shine,* *Nike+ FuelBand,* *Smartbands,* *Sony SmartBand,*

Date (2016)	Survey participation	Responses due to	Social media	Post characteristics and comments
				Fitness Tracker: Fitbit - Jawbone - Polar - Garmin. As of Mar 7th, no communities in Google+ were found for: Xiaomi Miband, Garmin (*Garmin Vivoactive* was found but was not considered since discussions were in French, therefore not considered), Basis Peak, Peak, iBasis, ihealth, Polar.
Mar 7th (cont.)	1 (cont.)	Actions until Mar 3rd (cont.)	Fitbit users' community discussion page[3], (using a Fitbit user account)	The following message was posted at the "Fitbit Community – Share your story"[4] page: *A research study is investigating the motivation of users and ex-users of wearable activity trackers. You can share your experiences during a 10-minute online survey at http://goo.gl/3eenOa, and then opt to participate in raffles of Amazon gift cards. Participation is anonymous.* *This invitation can be shared with your friends that use or have already used any wearable activity tracker.* On the next day the Fitbit user was notified by email by this community moderator that his post was removed since it was considered an advertisement.
			LifeTrak community public questions page[5]	The following message was sent and there was no reply, but it remains public open and is still available online[6]: **Subject**: *[Research] Quick survey with raffles of gift cards* ***Message**: I am Alessandra Brandao, currently working on a research study at RIT that is investigating the motivation of users and ex-users of wearable activity trackers.* *I would appreciate if you can help us by sharing this invitation so the users and ex-users of your product could fill in a quick online survey, in which they can opt to participate in raffles of Amazon gift cards.* *Our goal is to gather experiences of different users of any available brands in the market.*

[3] https://community.fitbit.com/t5/Discussions/ct-p/discussions
[4] https://community.fitbit.com/t5/Share-Your-Story/bd-p/greet
[5] https://lifetrak.zendesk.com/hc/communities/public/questions/203636557-What-s-the-community-
[6] https://lifetrak.zendesk.com/hc/communities/public/questions/209670557--Research-Quick-survey-with-raffles-of-gift-cards

Date (2016)	Survey participation	Responses due to	Social media	Post characteristics and comments
				In the case you cannot share this invitation with your customers, I would highly appreciate if you can indicate potential communities or forums where your customers are likely to engage in online discussions. *We believe the results of this study, which will be public, may benefit the community around these wearables.* *The invitation to participate is at the end of this message.* *Thank you,* *Alessandra Brandao* *"A research study at RIT is investigating the motivation of users and ex-users of wearable activity trackers.* *You can share your experiences during a 10-minute online survey at http://goo.gl/3eenOa, and then opt to participate in raffles of Amazon gift cards. Participation is anonymous"* Due to the no reply from Lifetrak and non-success in the Fitbit community, no other communities of other products were considered.
Mar 8th	8	Most likely due the post at Google+ on Mar 7th.	N/A	Actions this day were concentrated in monitoring potential results from the previous day's actions and investigating if paid advertisements in Facebook could contribute to get more answers; this option would be unfeasible since, as of March 8th, among the options to select technology of interest among Facebook users, there was no one specific for activity trackers to reach the target population.
Mar 9th	149	Relatively impressive result when compared to the previous days' response rate, which occurred after this day's actions were taken. The main reason is attributed to the attenuation of the formal language used in the Facebook posts, to a conversational style.	Facebook, *alessandra.david.524*	The message on Facebook as Mar 1st was updated and posted as: *Hi guys,* *I am working on an academic research that investigates the motivation of users and ex-users of wearable activity trackers. It would be very helpful to get the* [name of the community in Facebook] *community participation, since I am confident you may provide insightful information for our analysis. It takes only 5 min and you can opt to participate in raffles of Amazon gift cards by the end of the survey.* *I really appreciate your support. Thank you!* The content above was posted in several communities in Facebook: *Polar Loop Users;* *Fitbit 50+;* *Vivofit Community;* *Fitbit simple steppers;*

Date (2016)	Survey participation	Responses due to	Social media	Post characteristics and comments
				Stepping for weight loss - jawbone, Fitbit, misfit, Garmin; *Misfit Shiners;* *Jawbone UP-pers Unite.* However, both the last 2 communities cited above deleted the post after a few hours.
Mar 10th	161	Actions on Mar 9th	Email from a professor in GCCIS[7]	A professor in GCCIS forwarded the invitation to participate to his students.
After Mar 10th	23	No further posts were made online since the actions on March 9th resulted in 310 answers in two days; the survey total was 374. However, the number of ex-users' answers kept consistently low until the survey was finished.		

[7] Thomas B. Golisano College of Computing and Information Sciences at the Rochester Institute of Technology

Appendix F: IRB Approvals and Exemption

The following approval refers to the project initial scope. The images in this appendix were edited to remove the signature for security purposes.

R·I·T

Rochester Institute of Technology

RIT Institutional Review Board for the
Protection of Human Subjects in Research
141 Lomb Memorial Drive
Rochester, New York 14623-5604
Phone: 585-475-7673
Fax: 585-475-7990
Email: hmfsrs@rit.edu

Form C
IRB Decision Form

TO: Alessandra Brandao

FROM: RIT Institutional Review Board

DATE: **February 26, 2016**

RE: Decision of the RIT Institutional Review Board

Project Title – Reasons for reduction of motivation over time by users of wearable activity trackers

The Institutional Review Board (IRB) has taken the following action on your project named above.

☒ Exempt 46.101 (b) (2)

Now that your project is approved, you may proceed as you described in the Form A.

You are required to submit to the IRB any:

- **Proposed** modifications and wait for approval before implementing them,
- Unanticipated risks, and
- Actual injury to human subjects.

Heather Foti, MPH
Associate Director
Office of Human Subjects Research

The following image exhibits the IRB approval for this project updates regarding the complementary surveys.

R·I·T

Rochester Institute of Technology

RIT Institutional Review Board for the
Protection of Human Subjects in Research
141 Lomb Memorial Drive
Rochester, New York 14623-5604
Phone: 585-475-7673
Fax: 585-475-7990
Email: hmfsrs@rit.edu

Form C
IRB Decision Form

TO: Alessandra Brandao

FROM: RIT Institutional Review Board

DATE: **April 6, 2016**

RE: Decision of the RIT Institutional Review Board

Project Title – Reasons for reduction of motivation over time by users of wearable activity trackers

1. Survey Revision

The Institutional Review Board (IRB) has taken the following action on your amendments named above.

☒ Exempt 46.101 (b) (2)

Now that your project is approved, you may proceed as you described in the Form A.

You are required to submit to the IRB any:

- **Proposed** modifications and wait for approval before implementing them,
- Unanticipated risks, and
- Actual injury to human subjects.

Heather Foti, MPH
Associate Director
Office of Human Subjects Research

Appendix G: Specs Related to the Models Reported by the Survey Participants

Models	Count or track steps	Count or track distance	Track heartbeat	Calories burned	Track sleep	Alarm clock	Data in device	Data in app/web	Sharing data
Apple Watch	x	x	x	x	Through apps, not natively	x	x	x	Not found
Basis	x	Through app, not natively	x	x	x	x	x	x	x
Fitbit - Blaze	x	x	x	x	x	x	x	x	x
Fitbit - Charge	x	x	no	x	x	x	x	x	x
Fitbit - Charge HR	x	x	x	x	x	x	x	x	x
Fitbit - Flex	x	x	no	x	x	x	Light indicators	x	x
Fitbit - One	x	x	no	x	x	x	x	x	x
Fitbit - Surge	x	x	x	x	x	x	x	x	x
Fitbit - Zip	x	x	no	x	no	no	x	x	x
Intex - Fitrist	x	x	no	x	x	Not found	x	x	Not found
Garmin - Vivoactive	x	x	Requires heart monitor/strap	x	x	x	x	x	x
Garmin - Vivofit	x	x	Requires heart monitor/strap	x	x	no	x	x	x
Garmin - Vivofit 2	x	x	Requires heart monitor/strap	x	x	no	x	x	x
Garmin - Vivosmart	x	x	Requires heart monitor/strap	x	x	x	x	x	x
Garmin - Vivosmart HR	x	x	x	x	x	x	x	x	x
Humana Gear 2	x	Manual not found	Manual not found	Manual not found	Manual not found	Manual not found	x	x	Not found
iHealth	x	x	no	x	x	x	x	x	No
Jawbone model - UP	x	x	no	x	x	x	Status light only - active or sleep	x	x
Jawbone model - Up Move	x	x	no	x	x	x	Light indicators of status	x	x
Jawbone - Up 2	x	x	no	x	x	x	Light indicators of status	x	x
Jawbone - Up 3	x	x	x	x	x	x	Light indicators of status	x	x

Models	Count or track steps	Count or track distance	Track heartbeat	Calories burned	Track sleep	Alarm clock	Data in device	Data in app/web	Sharing data
Jawbone - Up 4	x	x	x	x	x	x	Light indicators of status	x	x
Jawbone - UP24	x	x	no	x	x	x	Light indicators of status	x	x
Misfit - Flash	x	x	no	x	x	Not found	Light indicators	x	x
Misfit - Link	x	x	no	x	x	Not found	Light indicators	x	Not found
Misfit - Shine	x	x	no	x	x	x	Light indicators	x	x
Misfit - Shine 2	x	x	no	x	x	x	Light indicators	x	x
Misfit - Speedo Shine	x	x	no	x	x	Not found	Light indicators	x	x
Misfit - Swarovski Activity Crystal	x	x	no	x	x	Not found	Light indicators	x	x
Nike+ Fuelband	x	no	no	x	no	no	x	x	x
Polar - A360	x	x	x	x	x	x	x	x	x
Polar - Loop	x	x	strap needed	x	x	no	x	x	x
Polar - Loop Crystal	x	x	strap needed	x	x	no	x	x	x
Polar - M400	x	x	strap needed	x	x	x	x	x	x
Polar - RC3	x	x	strap needed	x	no	x	x	x	x
Polar A300	x	x	strap needed	x	x	x	x	x	x
Samsung Gear S2	x	x	x	x	no	x	no	x	no
Sony - Smartband 2	x	x	x	x	x	x	no	x	no