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## Research and Applications

# Beyond novelty effect: a mixed-methods exploration into the motivation for long-term activity tracker use

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### ABSTRACT

**Objectives:** Activity trackers hold the promise to support people in managing their health through quantified measurements about their daily physical activities. Monitoring personal health with quantified activity tracker-generated data provides patients with an opportunity to self-manage their health. Many have been conducted within short-time frames; makes it difficult to discover the impact of the activity tracker's novelty effect or the reasons for the device's long-term use. This study explores the impact of novelty effect on activity tracker adoption and the motivation for sustained use beyond the novelty period.

**Materials and methods:** This study uses a mixed-methods approach that combines both quantitative activity tracker log analysis and qualitative one-on-one interviews to develop a deeper behavioral understanding of 23 Fitbit device users who used their trackers for at least 2 months (range of use = 69–1073 days).

**Results:** Log data from users' Fitbit devices revealed 2 stages: the novelty period and the long-term use period. The novelty period for Fitbit users in this study was approximately 3 months, during which they might have discontinued using their devices.

**Discussion:** The qualitative interview data identified various factors that users to continuously use the Fitbit devices in different stages. The discussion of these results provides design implications to guide future development of activity tracking technology.

**Conclusion:** This study reveals important dynamics emerging over long-term activity tracker use, contributes new knowledge to consumer health informatics and human-computer interaction, and offers design implications to guide future development of similar health-monitoring technologies that better account for long-term use in support of patient care and health self-management.

**Key words:** activity tracker, motivation, consumer health informatics, patient generated health data

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## INTRODUCTION

Activity tracking technology holds much promise for consumer health informatics, stimulating people to improve their health, and fitness practices.<sup>1–4</sup> Commercial activity trackers (also referred to as health trackers or fitness trackers), such as Fitbit and Xiaomi, enable users to generate health-related data, by allowing them to track their daily physical activity (PA) with measures of step counts, calories burned, activity level, walking distance, and sleep patterns.

Furthermore, activity tracking technologies, including activity trackers and their corresponding web applications, have demonstrated significant value for patient care and health-self management, in both clinical<sup>2–7</sup> and everyday life settings,<sup>8–10</sup> particularly for patients with lifestyle diseases such as diabetes and obesity.<sup>2,4,7</sup>

Despite the increasing perceived value of activity tracking technology, a survey of activity tracker users in the U.S. showed that over half of the users had discontinued using their devices and one-

third of users had discontinued within 6 months.<sup>11</sup> Such short term (i.e. <6 months) use is unlikely to bring about the sustained healthy lifestyle promised by the designers and marketers of activity trackers.

In human-computer interaction research, the *novelty effect* is defined as a person's subjective "first responses to [using] a technology, not the pattern of usage that will persist over time as the product ceases to be new, to him or her."<sup>12</sup> Prior studies have noted that as the novelty effect (NE) wears off, many users discontinue use of new technologies, such as domestic robots or text message reminders.<sup>12,13</sup> Initial research evidence suggests that declining NE is the probable reason for many activity tracker users discontinuing use of their devices.<sup>13-15</sup> Beyond this, however, few research studies the actual role of NE in the adoption and/or sustained use of activity trackers.

Findings in current user research with activity tracking technology tend to gloss over the NE, as many studies were conducted over relatively short-time sessions, usually between 1 and 3 months.<sup>14,16-18</sup> Consolvo et al.<sup>14</sup> are unusual in raising the possibility of NE's impact, in their acknowledgment that their findings in a 3-month study may not have fully overcome the effects of NE. This general research limitation underscores the necessity for longitudinal studies to investigate users' motivation after early use, and particularly after the NE has worn off.<sup>16,19</sup>

To our knowledge, few studies have examined long-term activity tracker use with a specific focus on NE.<sup>20,21</sup>

This research study explores the NE in the early stages (<3 months) of activity tracker adoption, as well as the motivation factors for sustained activity tracker use for the long term (i.e. for more than 6 months). Specifically, we focus on activity tracker users who continue to use their devices well after the NE has worn off, and we address the following 2 research questions:

RQ1: How does the Novelty Effect manifest itself in the early stages of activity tracker adoption?

RQ2: What factors motivate extended activity tracker use beyond the novelty period?

By answering these 2 research questions, we aim to develop an in-depth understanding of the impact on the NE on activity tracker adoption and the motivational factors behind sustained activity tracker use. We then derive design implications for activity tracking easier adoption and sustained use.

## BACKGROUND AND SIGNIFICANCE

### The adoption of activity tracking technology and the myth of novelty effect

The adoption of novel technologies has been investigated in many social science disciplines. The Diffusion of Innovations Theory provides the groundwork to examine how a new technology is accepted, rejected, or reevaluated over time within a certain cultural background.<sup>22</sup> The technology acceptance model and its subsequent research concluded that perceived usefulness and perceived ease of use determine willingness to use a technology, which further influences usage behavior.<sup>23,24</sup> These early works indicate that the novelty of a technology may negatively affect its adoption, specifically when the technology creates radical changes to a user's current practices or when users just want to try out the technology before making adoption decisions.

As the emerging activity tracking technology shows significant potential to support patient care and health self-management, researchers in both consumer health informatics and human-computer interaction fields have explored user adoption behaviors with wearable activity trackers on both research prototypes and consumer-facing products.<sup>16,17,25-27</sup> Shih et al.'s<sup>26</sup> 6-week study with 26 users based on Fitbit logs and survey shows that half of the participants abandoned Fitbit after 2 weeks. Similarly, Gouveia et al.<sup>17</sup> analyzed the usage data of their health tracking prototype (named as Habito) and found that only 97 adopters out of 256 users used the tracker for more than a week. These research results illustrate that short-lived use and low user adoption are major issues for activity tracking technology. To explore the underlying reasons causing these issues, Lazar et al.<sup>28</sup> focused on non-adopters who discontinued using the smart devices after 2 months, and identified reasons for their abandonment, concluded that devices were mismatched to participants' conceptions, the data generated by devices were considered not useful, and device maintenance was inconvenient.

Though many researchers state that the NE might have affected their study results, we still know little about how NE exactly impacts user adoption of activity trackers.<sup>14,17,26</sup> Our study examines how the NE manifests itself in the early stages of activity tracker adoption (RQ1).

### Motivational factors and persuasive technology

Beyond the NE, it is also critical to understand how various motivational factors impact user behavior during and after the novelty period. In 1990s, researchers in exercise behavior psychology employed self-determination theory to identify 2 basic types of motivation: self-determined intrinsic motivation and non-self-determined extrinsic motivation.<sup>29,30</sup> Ryan et al.<sup>31</sup> confirmed that intrinsic motivation was highly associated with long-term adherence to physical exercise. A more recent study found that various intrinsic and extrinsic motivational factors play different roles at different stages of people's exercise adoption and maintenance, while exercise maintenance is fostered by greater intrinsic motivation than extrinsic motivation.<sup>32</sup>

Activity trackers aim to help users live healthier lifestyles by increasing their physical activity levels, which can only be achieved through long-term. To address the issues of short-lived use and low user adoption, human-computer interaction researchers have recently focused on persuasive technology, which refers to technologies intended to change a person's attitude or behavior.<sup>33</sup> Today's consumer-facing activity trackers incorporate various persuasive features, including goal-setting, virtual rewards, and social influence.<sup>21,34</sup> Many of these features also employ game elements to reinforce different types of motivation: personal daily step goals enhance intrinsic motivation and social exercise leaderboards enhance extrinsic motivation. Recent research also indicates that personal factors, such as personality and preexisting motivation<sup>35,36</sup> may affect the effectiveness of certain persuasive technology features and users' adoption decisions.

Fitbit, a leading activity tracker manufacturer, has integrated many gamified persuasive technology features into its products, so we chose to examine Fitbit users for our study of the motivational factors behind sustained use of activity trackers (RQ2). We also favor the use of Fitbit devices in our study for their full range of functionality and user data consistency.

## METHODS

To explore user behavior with activity trackers and to identify factors that drive people to stay engaged with device beyond the erosion of the novelty effect, we employed a mixed-methods approach,<sup>37</sup> of quantitative and qualitative research methods in this longitudinal study.

Prior to initiating the project, the investigators obtained Institutional Review Board (IRB) approval. The subject population was staff and faculty in academic department of a state University, in the Southeastern United States. Recruitment was by word of mouth and email, followed by an email providing a detailed description of the study, what would happen in interview sessions, and that we would be asking for their consent to collect their Fitbit log data. Selection criteria for participants were that they be at least 18 years of age; currently using a Fitbit activity tracker; or had used one in the past but had since discontinued use. Participants were then informed of the procedures and purpose of this study before they signed an Informed Consent document.

Out of 23 participants, 16 ( $n = 16$ ) were female. All had adopted Fitbit devices of their own volition, continued to use them for an average 412.26 days (standard deviation [SD] = 295.62; range = 69–1073 days) and were willing to share their data. We used the Fitbit API (application programming interface) to retrieve these participants' step data and device use.<sup>38</sup> Before starting the interview, a focus group consisting of interview participants was conducted 1 month before the interview study started to help design the interview protocol with a focus on possible themes and interesting preliminary observations.

All participants were interviewed in person for 45–60 min. Interviews were audio recorded and transcribed verbatim. Questions focused on: (1) the motivations for adopting and using Fitbit; (2) specific capabilities of the device, and how participants made sense of their recorded data; and (3) potential changes in the use of the device over time (See [Supplementary Appendix SA Interview Guide](#)). Most interview questions were constructed by the first and third authors and reflected key concepts addressed by prior research on wearable device use, such as its social aspects<sup>14</sup> and motivation aspects.<sup>15</sup>

For qualitative data analysis, the 23 interview text data was analyzed inductively by 3 authors (first, third, and last authors) to develop themes and categories. Within each transcript, statements, or paragraphs providing information on some aspect of the concept (ie, motivation, technology) were identified and noted through iterative and inductive cycles. The 3 authors identified labels that best describe the participants' experiences, thoughts, or feelings about their Fitbit devices, and coded each transcript accordingly. The authors mainly focused on participants' thoughts about motivational factors that affect their decision to continue or discontinue using the device. In the process of developing emergent themes and categories, the constant comparison method,<sup>39</sup> was used, so that, whenever a new text was coded into a category, it was compared with those already in the category. The processes of data and transcript analyses were performed collectively by 3 authors. The fourth author contributed to further analytical discoveries.

For the quantitative data analysis, raw data were collected from users' Fitbit devices. We performed basic data analysis to record individual and mean registered steps and device usage (see [Table 1](#)). Linear regression models were employed to calculate the mean registered steps. The device usage rate is the total usage number of days over total ownership period (instances where zero steps are logged are indicative of a device nonuse day).

To further investigate the device usage, the low and high groups' usage patterns over time were represented in the graph ([Figure 1](#)), and a repeated measure analysis of variance (ANOVA) was applied to discover usage patterns in Week 3, Week 4, Month 3, and Month 6 as well as after 6 months of using an activity tracker. Welch's Unequal Variances *t*-test was employed to test significant differences within the low-usage group over time.

## RESULTS

### Results from quantitative log analysis

Our findings indicate that the 23 research participants exhibited a wide range of average level of usage: 13.13–100% (mean usage = 76.04%, SD = 25.70%). [Table 1](#) provides summaries of data collected from our participants that represent mean registered steps and device usage. Then, based on individuals' level of use ([Figure 1](#)), 2 distinct groups of device usage level were observed: Group 1 consisting of 14 participants in the high-usage group (71.29–100%) and 9 participants in Group 2, the low-usage group (13.13–66.66%).

To further investigate the 2 groups' usage patterns over time, a repeated measure ANOVA was applied to the usage data to examine the effects of time at Week 3, Week 4, Month 3, Month 6, and after 6 months of using an activity tracker ([Figure 1](#)).

Analysis of variance of the "Group × Time" interaction ( $F(4, 50) = 12.890, P = .001$ ) reveals a statistically significant association between time and response (mean usage). As illustrated in [Figure 1](#), participants in the high-usage group (Group 1) continued to use their activity tracker over time. On the other hand, there is a significant drop in usage by members of the low-usage group (Group 2), after 3 months.

To test significant differences within the low-usage group over time, the Welch's Unequal Variances *t*-test was applied. The *t*-test reveals that the average usage level of 51% dropped significantly after 3 months ( $t = -4.73, P < .001$ ).

Based on these results from our sample population, we infer that the period of "novelty" is approximately 3 months. As mentioned above, most of the previous studies on activity trackers were conducted over relatively short-time periods, which were likely not long enough to have accounted for the NE.<sup>40</sup>

[Figure 2](#) provides a Lattice graph that displays the multivariate relationships of the 2 different groups. The graphs illustrate individual's step counts and their dispersion into 2 activity (usage) groups. In general, the participants' average number of steps in the high-usage group (Group 1) is higher (mean steps = 8780.14, SD = 2425.78) than the average number of steps in the low-usage group (Group 2) (mean steps = 3160.44, SD = 1797.11). The average number of steps taken by Group 1 (see [Table 1](#)) maintained or increased from their baseline (Weeks 3–4) number of steps, while the average number of steps recorded by Group 2 fell significantly over the same period.

Compared with previous experimental work focused on short-term use,<sup>14,16–18</sup> our research used longitudinal data collection and analysis. In the next section, we triangulate these quantitative findings with our qualitative interview data, to explain the difference between the 2 groups and to identify motivational factors for sustained activity tracker use after the novelty effect wears off.

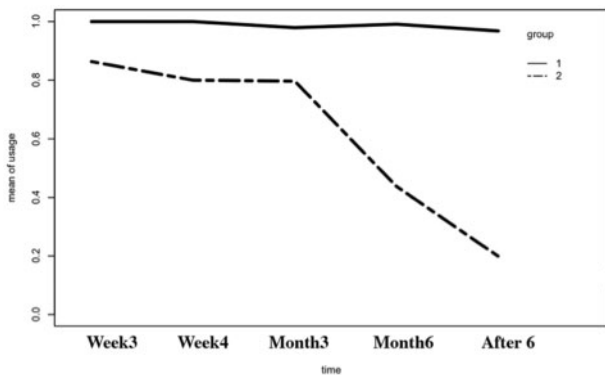
### Results from qualitative interviews

Findings from the interviews reveal 2 distinct stages: all of the participants went through Stage 1 (the novelty period), but not all were

**Table 1.** Summary of analysis of participants’ exercise performance data

Patient number	Gender	Mean registered steps (±SD)	Number of days device used	Number of days device unused	Device usage (%)	Group (1: high usage; 2: low usage)
1	Female	6604*** (±328)	224 (days)	0 (day)	100	1
2	Male	8679*** (±226)	453	17	96.38	1
3	Female	4797*** (±325)	137	91	60.08	2
4	Female	9723*** (±225)	464	12	97.47	1
5	Female	10 496*** (±416)	136	3	97.84	1
6	Female	4297*** (±305)	148	111	57.14	2
7	Female	2228*** (±290)	106	180	37.06	2
8	Female	793*** (±220)	65	430	13.13	2
9	Female	6493*** (±305)	259	0	100	1
10	Female	2835*** (±226)	235	236	49.89	2
11	Male	10 640*** (±304)	258	2	99.23	1
12	Male	7876*** (±225)	439	38	92.03	1
13	Male	9987*** (±229)	457	3	99.34	1
14	Female	1526*** (±391)	80	78	50.63	2
15	Male	14 595*** (±161)	929	2	99.78	1
16	Female	2723*** (±239)	172	248	40.95	2
17	Male	9428*** (±571)	53	21	71.62	1
18	Female	6641*** (±591)	46	23	66.66	2
19	Female	7961*** (±381)	165	1	99.39	1
20	Female	2604*** (±344)	128	75	63.05	2
21	Female	4188*** (±150)	765	308	71.29	1
22	Male	8358*** (±160)	932	8	99.14	1
23	Female	7894*** (±160)	820	124	86.86	1

\*\*\*P-value: <2e<sup>-16</sup>.  
SD: standard deviation.



**Figure 1.** Two groups’ device usage patterns over time (the high-usage group vs the low-usage group).

motivated enough to embark on Stage 2 (long-term use, 6 months or more). Figure 3 provides an overview of our findings on the motivational factors during the different stages of activity tracker use. Curiosity about data and curiosity about technology are early motivational factors in Stage 1; informational, technological, and situational factors foster extended device use after the novelty period (ie, beyond 3 months’ use); personal, social, and gaming motivations support long-term activity tracker use in extended use beyond the novelty period (see Stage 2 in Figure 3).

Table 2 provides sample quotations from qualitative interview data that explain these motivational (and inhibitors of use beyond the novelty period) factors. In the next section, we present in-depth discussion on how these factors impact activity tracker user behavior in different stages over time.

Our participant sample drawn from the personnel of an academic department can be characterized as having a higher affinity with digital technology and media than average users. This can be viewed as a limitation to the study’s findings. However, as displayed in the Results section above, our sample reflected a remarkably broad and diverse range of perspectives toward digital devices. Whereas some participants were naturally more curious about new digital technology and its functionality (technophiles), others considered themselves only interested in the direct utility of digital devices and their relevance to personal lifestyle. The sample also included a few individuals who were indifferent or even skeptical about their Fitbit device, and used it (often for a short period) only because they had received it as a gift.

Sample interview quotations are summarized in Table 2 and discussed in further detail below.

### Stage 1: novelty period

Participants began using their Fitbit device with different motivations. Among these, 2 forms of curiosity served as important motivators: curiosity about data on patterns of physical activities, and curiosity about the technology itself. In this stage, all participants used the device for at least 4 weeks and they reported increased awareness of their daily activity levels after using the device.

### Curiosity about data

Most of the participants noted that their initial motivation for using the activity tracker derived from desire to track activity-related data generated by the device; thus, the use of the device to satisfy the participants’ curiosity about their activity level. Participant 9 mentioned that her primary motivation for getting the device was to confirm her inactivity: “I think my primary thing has been trying to confirm

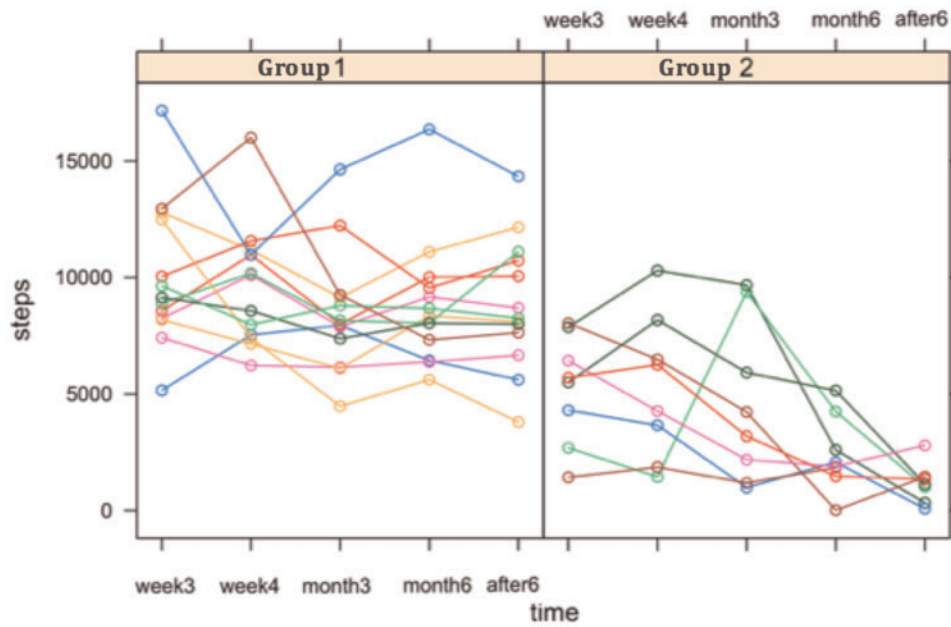


Figure 2. Lattice graph: step differences between the 2 groups over time.

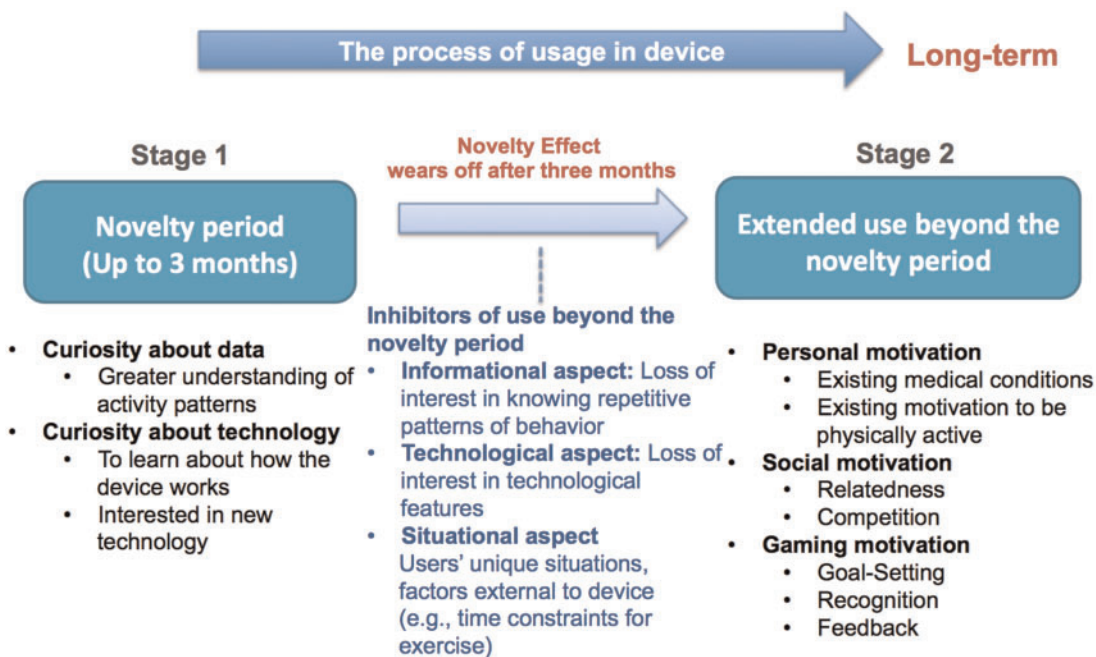


Figure 3. Motivational factors during the different stages of activity tracker use: the process of usage in device before/after novelty effect wears off.

my inactivity. I had ideas about what was making me inactive like particular times of the year when I would get busier than others and I would just forget to move ... I really wanted to confirm what was going on so I could try to fix that" (P9). Participant 10 already used a pedometer to track her physical activity, but she thought pedometers were rudimentary and didn't provide that much information: "It was really [good] to see for myself I was already doing something, but to see more specifically what was happening at the end of the day. So I knew I did the exercise and I knew I was walking, but I didn't know [the data]. It [Fitbit] would tell me you did how many miles or how many steps today" (P10). By knowing their specific

number of steps, participants indicated that they had a better understanding about their activity patterns. Participant 9 reported that the device enhanced her awareness: "I think so cause again I told you I wanted to increase my awareness about my inactivity and so I'm much more aware now (after using this device) when there's a period of inactivity coming" (P9). We suggest that the information novelty of the device's informational features may wear off, after users gain sufficient understanding of their data patterns, and begin to lose interest in using the device. This view builds upon previous evidence that activity tracking devices provide greater awareness about one's activity.<sup>1,18</sup>

**Table 2.** Sample quotations from 23 participants

Motivational factor	Sample quotations
<b>Stage 1: novelty period</b>	
Curiosity about data	<p>“It was really to see for myself I was already doing something, but to see more specifically what was happening at the end of the day.” (P10)</p> <p>“To increase my awareness of what I was or was not doing from a physical fitness, I am wired for data and so quantifying my effort or lack of effort was a quick way to have a baseline.” (P13)</p> <p>“The other thing was it was kind of fun to see how many steps you got, you know.” (P16)</p> <p>“Just to kind of remain aware of how much I was sitting versus how much I was moving.” (P18)</p> <p>“I was just interested to see how far I went. I think it never, I could never, I could never remember how, and I was like oh I ran this far, I ran from here to here to here to here and I don’t remember how, you know, it’s like I’m not very good at judging distance. Like this is not, you know, because it uses GPS and it tells you how far you went.” (P19)</p>
Curiosity toward technology	<p>“We’ll see what we can learn from it and so I’ll try one and it’s fun.” (P2)</p> <p>“To learn more about how these things work, to understand about how to motivate people in terms of fitness and activity.” (P5)</p> <p>“I had been hearing a buzz about Nike Flex and different things and people have those Garmin Watches that track the calories and stuff and I said well let me try it and see what the buzz is about.” (P6)</p> <p>“All to get it for myself it was to understand this new technology that was different than the Nike Fuel and so for me it was you know let’s test this one out and it seemed to be getting some popularity, got discussed by people in the popular press.” (P22)</p>
<b>Inhibitors of use beyond the novelty period</b>	
Informational aspects: loss of interest in knowing repetitive patterns of behavior	<p><b>Sample quotes</b></p> <p>“I was really interested in the sleep part, but after doing the sleep part for oh I don’t know 6 months or so I could see the pattern and it was pretty much unchanging.” (P4)</p> <p>“Right, like my parking place didn’t change, my office didn’t change, my work hours didn’t change, my night time walk route didn’t change so I didn’t feel like it was going to add to my, it then felt like extra, like I already had the knowledge of what I needed to do, I could tell you if I was getting a 10 000. So the machine now or the instrument now was not, the flower wasn’t drawing me back in.” (P20)</p> <p>“It was very interesting learning sleeping habits and now that I’ve learned them I don’t do it anymore.” (P12)</p>
Technical aspects: loss of interest in technical features	<p>“I mean that part of it was kind of interesting. It was like a novelty for me, you know, it was kind of like oh this is kind of cool I get to see what I’m doing you know but then once the novelty sort of wore off.” (P8)</p> <p>“I don’t do that (receiving badges) anymore personally because it was the novelty effect, oh it’s kind of cool I’m getting points right, but the other is just that that part of it just seems to . . .” (P15)</p>
Situational aspects	<p>“It didn’t really It didn’t really have anything to do with it, it was just the reason I stopped using it was because I still didn’t have time to do the exercise and this didn’t give me time.” (P8)</p> <p>“I know that I need to be, but again I guess it goes back to that whole time thing and no and not just with, I still have a kid who’s in high school and between the job and then rushing to either get him at school or to take him to practice.” (P3)</p>
<b>Stage 2: long-term use</b>	
Personal motivation: existing medical conditions	<p>“I had a medical condition [arthritis hip], and so over time I moved less and less. What happened was I had the hip operations, and then I could walk. And I got the Fitbit, and then I realized that I had to undo and relearn and be efficient in my movements, so that I’m moving around the house a lot more than I used to.” (P4)</p> <p>“My general practitioner is always trying to get me to lose weight. If I have a cold it’s because I need to lose weight, and she’s just sure that the vein of everything right and because she works out all the time. So when I told her I was doing Fitbit she was like I’ve heard of that and she actually put that into my health records that I was doing Fitbit and I was trying to take some advantage of ways to make my health better.” (P9)</p>

(continued)

Table 2. continued

Motivational factor	Sample quotations
Personal motivation: Existing motivation to be physically active	<p>“I mean I had a bachelors in recreational therapy, so and physical activity. I mean you know I was a gymnastics instructor, I’ve always been interested in how physical activity, how we can motivate especially young people.” (P5)</p> <p>“This would really make me exercise and I must admit it has made me exercise more than I’ve ever exercised before. I’m probably never going to be a real physically fit person but. . .” (P21)</p>
Social motivation: Relatedness	<p>“I really appreciated the camaraderie aspect of it and I wanted to participate in the Asparida Core, so that was very important to me, be a good team player. Because I think it did help folks get to know each other better, bond better, it reinforced healthy behaviors.” (P19)</p>
Social motivation: Social competition	<p>“We kind of compare how many steps we get and participants 3 &amp; 10 and I were in a race on the website. We were in a race to see who could be at the top; who could get the most steps in in a day, and we would e-mail each other back and forth: ‘I beat you!’” (P6)</p>
Gaming motivation: Recognition	<p>“They send it to me and it (badges) just comes and it’s very pleasing. They’re just pleasing.” (P4)</p> <p>“Well 10 000 was the average goal but I found that I easily walked 3000 and then if I pushed myself 5000 was accomplished, and then if I’d go for a walk during lunch 7000. So I could see how adding on activity got me to that goal and I loved getting the acknowledgement, you know, the badges. I loved that, that’s great, yeah, that’s fun.” (P14)</p>
Gaming motivation: Feedback	<p>“The only thing I thought was fun was the little messages, like congratulations you rock, let’s go, hello, you know, which I thought was really cool to put into a little tiny device, these little messages.” (P7)</p> <p>“I like the function of the Fitbit more because I can download the data and it also talks to me, like it says good job, and the flower grows. I sort of like that whole package, so I’m more interested in using the Fitbit moving forward.” (P14)</p>
Gaming motivation: Goal setting	<p>“I was really scared because you know the baseline is 10 000 steps and I was like oh my gosh how far is 10 000 steps. The image in my head was me standing at the bottom of a mountain going how am I going to get up there. So what I did for myself is I switched the goal down to 5000 steps, no 2500 steps, that’s what I switched it to first and after I realized out of the course of my day how easy that was I switched it to 5000 steps and I incorporated more walking, you know, what the doctors tell you, park further away, use the stairs instead, so I started incorporating those simple life changes.” (P6)</p>

### Curiosity toward the technology

Some of the participants took a specific interest in a ubiquitous technology like Fitbit and were primarily curious about the specific features and benefits of the latest model and in comparing it with other devices. One participant used the Nike Fuel tracker before getting the Fitbit device, as he wanted to compare: “[the purpose] was to understand this new technology that was different than the Nike Fuel and so for me it was, let’s test this one out and it seemed to be getting some popularity, got discussed by people in the popular press” (P22). Some participants became interested in activity trackers having seen others use it: “I had been hearing a buzz about Nike Flex and different things and people have those Garmin Watches that track the calories and stuff, and I said well, let me try it and see what the buzz is about” (P6). Noticeably, several of these participants had tried other mobile apps or devices for activity tracking before, so their familiarity with the technology made it easier for them to accept and then adopt Fitbit.<sup>23,24</sup>

### Between two stages

As shown in Figure 1, compared to the high-usage group, participants in the low-usage group discontinued using the activity trackers

after a few months. We discovered 3 that impede the continued use of the device: informational, technological, and situational aspects.

### Informational aspect: loss of interest in knowing repetitive patterns of behavior

We found that by quantifying movements and generating personal health and wellness data, Fitbit devices increased participants’ awareness of their own physical activity. Based on our interview data, all 23 participants in the study benefited from this informational aspect of the device; that is, all used the information generated by the device and increased their awareness. Regardless of their pre-existing situations and motivating factors, all subjects became more conscious of their daily activity levels after using the device. However, for some users, the informational benefits of the device dropped dramatically after learning about their routine lifestyle patterns. Participant 12 explains why sleep data is not useful anymore: “It was very interesting learning sleeping habits and now that I’ve learned them I don’t do it anymore” (P12). As mentioned above, we argue that the novelty of the informational features of the device wears off after users gain sufficient knowledge about their data patterns. This decreased perceived value of data generated may also lead to abandonment.<sup>28</sup> Similar prior research hints at the power of

the novelty effect, in which Epstein et al.<sup>41</sup> suggested that designers consider renewed variations of data presentation and visualization, in order to sustain users' interest in their device's informational aspects. Our own findings call for advanced design features such as personalizable data analytics that continuously provide users with unique insights into their daily physical activity.

### Technological aspect: loss of interest in technological features

Likewise, some may lose interest in the technology once they think they have learned enough about its novel technological features. For example, Participant 15 reported that he enjoyed receiving badges: "Essentially it's just like the motivation for the badges . . . where I would actually have time before I realized—oh if I walk 50 more floors today I'm actually going to get this badge—I would start changing my behavior a bit, you know. I'd go out at night and do a few more walks up and down hills, which is ridiculous . . . I don't do that anymore personally because it was the novelty effect" (P15). From the user's perspective, the technical features that the user had previously thought interesting turned into an obstacle after the NE wore off. This resonates with previous work<sup>28</sup> indicating that device maintenance might become a burden after the novelty period, which could be mitigated through improved non-intrusive design of activity trackers that requires minimal user efforts.

### Situational aspect

No matter how attractive the functions are, the device becomes useless if users' unique situations are not fully considered. Participant 8 expected the device to be a good motivator, but she pointed out that she was more concerned about the time constraints: "I thought it actually might motivate me to get more exercise, but it didn't really have anything to do with it . . . I mean the reason I wasn't exercising and the reason I'm not exercising is because I don't have time and this [Fitbit] doesn't give me time" (P8). Similarly, another participant indicated lack of time as the reason she cannot keep using her device: "I'm not as active as I had been. I know that I need to be [active], but again I guess it goes back to that whole time thing and not just with [this month] . . . I will say [the same] in December and January, and February too, I still have a kid who's in high school and between the job and then rushing to either get him at school or to take him to practice, or go to one of his wrestling meets . . . because that's the kind of mommy I am" (P3). This result calls for personalized motivation designs that account for the contextual factors of each user.

### Stage 2: the long-term use

The qualitative analysis of the interview data identified personal motivation, social motivation, and gaming motivation as 3 primary factors that encouraged participants' long-term device use beyond the novelty period.

#### Personal motivation

*Existing medical conditions.* We found that a personal health background such as a history of surgery, obesity, or insomnia could have motivated some users to sustain using the device in the hope that they would attend more effectively to their health issues. Participant 4 described her medical condition and how that has influenced the way she used the device: "I had a medical condition (arthritic hip),

and so over time I moved less and less. What happened was I had the hip operations, and then I could walk. And I got the Fitbit, and then I realized that I had to undo and relearn and be efficient in my movements, so that I'm moving around the house a lot more than I used to." In a similar fashion, participant 9, who from a weight problem notes: "My general practitioner is always trying to get me to lose weight. If I have a cold it's because I need to lose weight, and she's just sure that the vein of everything right and because she works out all the time. So when I told her I was doing Fitbit she was like I've heard of that and she actually put that into my health records that I was doing Fitbit and I was trying to take some advantage of ways to make my health better" (P9). Among our participants, most of the people who had an existing medical condition belonged to the high-usage group. The willingness to be healthy is a powerful motivation to continue using the activity tracker.

*Existing motivation for exercise.* We found that the existing motivation to increase physical activity could have motivated continued use among some users, who were interested in more specific data about their activity patterns. Participants 5 and 21 are in the high-usage group and desire to be more active. "I mean I had bachelors in recreational therapy, so and physical activity. I mean I was a gymnastics instructor, I've always been interested in physical activity, [and] how we can motivate especially young people" (P5). Similarly, P21 stated: "This would really make me exercise and I must admit it has made me exercise more than I've ever exercised before" (P21). This finding resonates with preexisting motivation may positively impact user adoption of activity trackers.<sup>36</sup>

#### Social motivation

*Relatedness.* Relatedness, a basic psychological need to spark intrinsic motivation, implies feeling validated by connecting to others within social surroundings<sup>42</sup> and is often used to encourage people to exercise.<sup>43</sup> A few participants found it inspiring that individuals around them (family members or coworkers) used activity trackers. "I really appreciated the camaraderie aspect of it and I wanted to participate in the Asparida Core, so that was very important to me—be a good team player" (P15). P8 noted: "Because I think it did help folks get to know each other better, bond better, it reinforced healthy behaviors" (P8). Participant 16 also felt connected with others: "The social aspect of it makes it a lot more acceptable. Since our participants worked in the same academic department and used the Fitbit device, they easily felt a sense of connectedness to each other by sharing activity data and experiences using the device" (P16). These results confirmed that building relatedness through supportive sharing is effective in persuasive technology.<sup>16,34</sup>

*Social competition.* Fitbit's social features that allow users with social ties to share and compare the data created some form of competition among users. Such social competition created by the use of the device encouraged them to use the device over a longer period time. Participant 6 demonstrates the motivation arising from the competition: "We kind of compare how many steps we get and Participants 2 and 11 and I we were in a race on the website. We were in a race to see who could be at the top, who could get the most steps in a day, and we would email each other back and forth, 'I beat you!.'" Participant 6 considered herself a competitive person. "Yes, it's not my total drive, but I need to be at least in the middle of the pack,



right. So if there were 10 people I wouldn't want to be the low person" (P6). The social competition feature of Fitbit worked as a strong extrinsic motivation for those who considered themselves to be competitive.

**Gaming motivation.** Gamification is described as "the use of video game elements to improve user experience and user engagement in non-game services and applications."<sup>44</sup> Fitbit has implemented numeric gamified features through its challenges, where users can compete with others within their social fitness circles. The major gamified features of Fitbit include recognition, feedback, and goal setting, which motivated some participants in this study to keep using their devices. Our findings confirm that incorporating game elements into activity trackers is effective in motivating users to be more physically active,<sup>44</sup> and we discussed the 3 gamified features in details below.

**Recognition.** Fitbit offers badges whenever the user achieves certain activity levels. Such virtual rewards encouraged some participants to use the device persistently. Participant 4 stated: "They send it to me and it (badges) just comes and it's very pleasing. They're just pleasing" (P4). For Participant 14 "Well 10 000 was the average goal but I found that I easily walked 3000 and then if I pushed myself 5000 was accomplished, and then if I'd go for a walk during lunch 7000. So I could see how adding on activity got me to that goal and I loved getting the acknowledgement, you know, the badges. I loved that, that's great, yeah, that's fun" (P14). Receiving badges was an important recognition of users' achievements toward a healthy lifestyle, encouraging some participants to be more physically active. Our qualitative analysis that recognition features worked best for users who acknowledgment for their accomplishment.

**Feedback.** Fitbit devices also provide users timely visual or textual feedback, such as a flower or a message, which represent users' progress towards their personal goals. These features were efficient motivators for some participants by providing them meaningful data about their daily physical activity levels. "I like the function of the Fitbit more because I can download the data and it also talks to me, like it says good job, and the flower grows. I sort of like that whole package, so I'm more interested in using the Fitbit moving forward, but the pedometer without the noise was perfectly adequate" (P14). P10 likes the messages: "like congratulations you rock, let's go, hello, you know, which it thought was really cool to put into a little tiny device, these little messages" (P10). Participant 7 also stated that she preferred interactive feedback: "When you hit the button you get a (flower), it's really kind of interesting, you get a flower to say it's on but then it says if you haven't worn it for a while it gives you like little other things, it's like interactive things, it's like an animate and it's computerized but you're talking to it

right, so it says 'hi', or I mean it comes up on a little screen and it says 'you rock' if you haven't used it in a while" (P7). We found these feedback features affected participants in different manners, depending on their personality, situations, and their motivation. This suggests there are no "best motivators" and that it's essential for developers to underscore the motivation for diverse users.

**Goal setting.** Goal setting is an effective strategy for behavior change<sup>45</sup> and Fitbit devices have incorporated goal setting features. Participant 6 mentioned she preferred to set her own goals: "I was really scared because you know the baseline is 10 000 steps 10 000 steps and I was like oh my gosh how far is 10 000 steps. The image in my head was me standing at the bottom of a mountain going how am I going to get up there. So what I did for myself is I switched the goal down to 5000 steps, no 2500 steps, that's what I switched it to first and after I realized out of the course of my day how easy that was I switched it to 5000 steps and I incorporated more walking, so I started incorporating those simple life changes" (P6). Based on our analysis, the users wanted to create the activity goal by themselves based on steps, distance, or active minutes. This is a more effective way for users to tailor their goals to what works best for their lifestyles and values. This finding resonates with the previous literature that self-set goals or goals chosen with a supporter (eg, fitness expert) were viewed more positively than goals that others have assigned.<sup>15</sup>

## DISCUSSION

This study's quantitative findings suggest that the novelty period for most research participants lasts about 3 months, and qualitative data explain why certain groups of users may use the activity tracking devices beyond this novelty period. These findings make clear that what makes users continue using the device beyond the novelty period does not necessarily lie in the device or its features but arise from user's context as well as existing intrinsic and extrinsic motivations. These factors relate to what researchers call the social and personal contexts of personal informatics research.<sup>46,47</sup> Table 3 outlines some of these contextual factors.

This is not to say what various activity trackers provide are not important, but they matter in so far as they interact with the personal and social contexts of use and reinforce existing user motivation.

What causes positive changes in user behaviors (eg, more activity) is therefore rooted in how strongly the device supports users' existing personal and social context. If the user is lacking social or personal motivation to increase daily physical activity levels, the device is not likely to create such motivation (contrary to the promotional narrative some vendors use), and users are likely to abandon the device after the novelty effect wears off. As a relevant example, users who have intrinsic motivation to exercise are more likely to

**Table 3.** The key aspects of social and personal contexts of use and relevant features and utilities of activity tracking devices

Context of use	Dimensions	Key features and utilities
Personal context/characteristics	Preexisting health issues Athletics and physically active users Quantified-selfers Gamifications	Monitoring and motivating features Features that track physical activities they already enjoy and appreciate Continuous data collection and analysis about self
Social context	Conversation and sense of community Social competition	Features supporting personal goal setting, recognition and feedback Physical appearance of the (wearable) devices as shared symbols of fitness Features encouraging competition such as Fitbit challenges

find the device and its system of informational and motivational features useful for tracking and motivating further physical activities. If they enjoy exercise (without the need for any extrinsic reward), they may appreciate the value of tracking and data analysis more; even if the novelty of bells and whistles diminishes over time, they may find a longer-term companion in the technology that keeps providing information and reminders about (physical) activities they enjoy.

This work provides 2 sets of design implications. First, contextual factors highlighted in Table 3 can serve as basic ingredients for designing and implementing relevant user personas to distinguish various user groups and their characteristics. Personas are often formed around parameters such as goals, skills, motivations, demographic attributes and attitudes.<sup>48</sup> Second, the findings accentuate the relevance of personal and social factors of long-term activity tracker use. Many unpredictable uses of the devices and the unique ways users may make sense of them (before, during and after the novelty period) can be traced to the interaction between the users' personal and social contexts. Therefore, future activity tracking technology design should be mindful of the way these contextual factors at 2 levels may intersect and result in distinctive adoption behaviors.

## CONCLUSION

Commercial activity trackers face the issues of short-lived use and low-user adoption that does not lead to meaningful behavior change. This research examined the impact of the novelty effect on activity tracker adoption and various motivational factors for sustained use beyond the novelty period, which revealed important dynamics emerging over long-term activity tracker use. This work contributes to consumer health informatics and human-computer interaction studies by extending previous shorter-term experimental research on activity tracker adoption and use. Finally, this research offers design implications to guide future development of similar health-monitoring technologies that better account for long-term use in support of patient care and health self-management.

## SUPPLEMENTARY MATERIAL

Supplementary material is available at *Journal of the American Medical Informatics Association* online.

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