Design Opportunities in Three Stages of Relationship Development between Users and Self-Tracking Devices

Da-jung Kim, Yeoreum Lee, Saeyeong Rho, Youn-kyung Lim
KAIST (Korea Advanced Institute of Science and Technology)
Daejeon, Korea, Republic of
{dajungkim, yeoreum_lee, saeyoung.rho, younlim}@kaist.ac.kr

ABSTRACT
Recently, self-tracking devices such as wearable activity trackers have become more available to end users. While these emerging products are imbued with new characteristics in terms of human-computer interaction, it is still unclear how to describe and design for user experience in such devices. In this paper, we present a three-week field study, which aimed to unfold users' experience with wearable activity trackers. Drawing from Knapp's model of interaction stages in interpersonal relationship development, we propose three stages of relationship development between users and self-tracking devices: *initiation & experimentation, intensifying & integration,* and *stagnation & termination.* We highlight the challenges in each stage and design opportunities for future self-tracking devices.

Author Keywords
Self-Tracking Device; Human-Technology Relationship Development; User Experience Design

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION
Self-tracking devices such as wearable activity trackers recently have become more available to end users. As noted in recent literature on smart products [21], emerging self-tracking devices are imbued with new characteristics in terms of human-computer interaction. For instance, the scope of human-computer interaction is not limited to a tangible device itself but includes the services the device provides, such as recommendations for health behaviors. In addition, the contents as well as the value it provides to users will be realized, tailored, and potentially evolve through the use of the device over time based on the ever-increasing data from individual users. While these characteristics imply that self-tracking devices do not simply follow the input-output interaction, little is known about how this emerging form of interaction between users and self-tracking devices can be described and what should be considered in the design of such smart products.

With this lack in mind, we conducted a study to unfold users' experience with wearable activity trackers. We thought that wearable activity tracker is one of the great examples of self-tracking devices to be studied, because it has been increasingly adopted in the market but also known for high rate of abandonment [9]. From the study, we found that users build an evolving relationship with their activity trackers, which we will describe in three stages. Also, users' experiences at certain stages of the relationship were affected by the quality of social transactions between users and their tracker systems. In this paper, we present three stages of relationship development between users and self-tracking devices by applying an interpersonal communication theory. By doing so, we suggest a new perspective for understanding and designing for user experience with self-tracking devices.

BACKGROUND
User Experience with Self-Tracking Tools
Studies in HCI have led to the understanding of patterns and issues with regard to in situ user experience with self-tracking tools, such as the styles of activity tracking [16] and perceived errors and common pitfalls of tracking and inferring activity data [2, 3]. Recent studies on commercial wearable activity trackers have also revealed novel challenges, such as issues with remembering to wear a device and the aesthetics of devices [18]. While the work by Li et al. [12] is aligned with this paper in a sense that they also discussed how users' interaction with self-tracking tools changes over time, we focus more on unfolding the evolving forms of interaction between users and self-tracking systems, rather than the practices of self-reflection upon which they focused on. In addition, by using an interpersonal communication theory, we introduce a novel perspective for understanding user experience with self-tracking devices, which concerns the development of a relationship between users and self-tracking systems and the quality of social transactions between them.

Social Transactions between Humans and Computers
Even before the recent self-tracking devices, there had been studies that showed how people socially respond to computing technologies by emotionally being involved in systems, treating them as social actors, or by using the norms

CHI'16, May 07-12, 2016, San Jose, CA, USA
© 2016 ACM. ISBN 978-1-4503-3362-7/16/05…$15.00
DOI: http://dx.doi.org/10.1145/2858036.2858148

between humans when they interact with computing systems [4, 15]. Also, several works have investigated how people build a relationship with technological artifacts and how those artifacts can be improved through interactions over time with people in everyday contexts [6, 13, 22]. We extend this understanding of the relationship between users and technologies in the emerging context of self-tracking devices.

FIELD STUDY

We conducted a three-week field study to unfold people's experiences with wearable activity trackers. For the study, we deployed two commercial activity trackers, Fitbit Flex and JawboneUp 24, both of which had dominant market share as of our study, July 2014. We were interested in exploring whether the different designs for interaction in the two tracker systems would affect the quality of user experience or not. Through the screening survey of 48 applicants, we recruited eight novice users (four males) to investigate their genuine thoughts on, feelings about, and behaviors with their first experiences with the systems. The selected participants were Koreans in their 20s or 30s, mostly undergraduate and graduate students, who had an interest in using the newly released activity trackers. They had a varying range and degree of interest in health activities (e.g., having a great interest in dietary information or enjoying playing baseball regularly). We refer to each participant by their participant number and the initial letter of the device they used in the study (e.g., F1, J1).

The three-week user study was designed to effectively observe the different use phases of activity trackers by simulating user experience from installation to uninstallation. At first, we provided one of the trackers to the participants and let them install the tracker by themselves. Then, participants were asked to use the activity tracker as they liked for three weeks, during which time we aimed to capture their experiences with diverse aspects of the tracker systems. Finally, at the end of the third week, they were asked to uninstall the tracker device. We asked them to think aloud during the installation and uninstallation so as to capture the vivid initial experiences with the systems instead of relying on recalls and to reveal the vivid terminal experiences as well, which were rarely addressed in the previous literature. We conducted weekly interviews with each participant to investigate the use pattern and the perceived benefits and difficulties of using the systems. With the aim of observing participants' natural engagement with the trackers, we did not force them to use the trackers until the end of the study. Rather, in the weekly interviews we inquired what and why some features of the activity trackers were not fully used. In addition, we provided a diary and asked participants to write their thoughts, feelings, and/or episodes related to the use of the activity trackers to capture a more nuanced experience that might not be discovered through the interviews.

We transcribed all the data from the pre-survey, weekly interviews, and diaries, which created over 130 anecdotes regarding the tracker users' experiences. We developed initial open codes by reviewing the data and iteratively analyzed the emergent patterns and themes across the data. Four of the authors conducted this iterative open-coding analysis together and reached consensus with regard to coding as well as the three stages we will report in the following section.

THREE STAGES OF RELATIONSHIP DEVELOPMENT BETWEEN USERS AND SELF-TRACKING DEVICES

From the data analysis, we found that participants built an evolving relationship with their activity trackers, and their experiences at certain stages of the relationship were affected by the quality of social transactions between the users and their tracker systems. We identified three stages of evolving relationships and transactions between a user and a wearable activity tracker, namely, i) *initiation & experimentation*, ii) *intensifying & integration*, and iii) *stagnation & termination*. In determining the stages, we were inspired by Knapp's model of human relationship development [7], which describes ten stages of interpersonal interactions in two directions of relationship development: coming together and coming apart. According to the model, the ways of coming together include the stages of *initiation, experimentation, intensifying, integration,* and *bonding*. The ways of coming apart involve the stages of *differentiation, circumscribing, stagnation, avoidance,* and *termination*. Although we adopted the terms proposed in Knapp's model in a much simpler manner, human behaviors described in this model enabled us to concretely elaborate on the evolving characteristics of the interactions between users and wearable activity trackers and to highlight the issues and design opportunities in each stage from a new perspective.

Initiation and Experimentation Stage

When the participants first encountered the given wearable activity tracker, they explored and experimented various aspects of the tracker system to understand what it is, how it works, and what value it would seemingly provide to them. Based on that, they got a sense of what features they would likely to use more or less. This process was quite similar to the series of behaviors people display when they first meet another person [7]: initiating a conversation with greeting, exchanging demographic information, and asking questions in order to seek the common interests or experiences.

The Challenge: The Gap between What People Imagined and What the System Could Do in the Initial Stage

As it is important to make a good first impression for the further development of an interpersonal relationship, we found this first moment was also important in the use of wearable activity trackers. Nevertheless, building a good first impression was especially challenging in the context of activity trackers like Fitbit and Jawbone because the actual contents that would help users make the decision to adopt the product were often in a blank state, which is also known as a cold-start problem in many recommender systems [17].

Wearable activity trackers, however, have been promoted for their advanced capabilities. As a result, some of the

participants had a high level of expectation for the "smartness" of the systems, which also resonates with the findings in [18]. Those participants tended to hold too high of expectations for the automation and intelligence of the systems. They described that their activity trackers *"would record activities very conveniently"* (F1), even if they do not invest much effort, as the device *"seems to be carefully programmed"* (J3), and *"seems to be more accurate than other mobile applications for self-tracking"* (F4). Thus, the gap between what people imagined and what the systems could actually do at this stage often resulted in confusing and disappointing experiences. For example, F3 failed whenever he tried to use a third-party application, MapMyFitness, because he believed the app would automatically receive his running data from his Fitbit and, thus, did not manually trigger the logging. Meanwhile, making the first impression was also challenging for some of the participants who distrusted the reliability of data collected through current technology. They tended to poorly judge the potential value of tracking certain data in a very early stage of use. J1 said, *"I will never use the meal logging. It is obvious that the tracker won't automatically recognize what I had for lunch and it would require manual logging. It is impractical and even unreliable."*

Design Implication: Designing the First Conversation to Help Systems and Users Get to Know Each Other Better

These findings highlight how proper communication of the immaturity and blank state of self-tracking devices would help reduce the possibility for misled expectations and early abandonment of the devices. However, current designs for this initial stage are often oriented toward explaining the technical steps of connecting a device with a mobile application. Although such instructions can be useful, this hardly helps users understand what a system can and cannot do in the initial stage. A system could be designed to better inform users how the system's potentials can be realized if it is properly used by the users. For instance, this initial stage could be designed with a series of conversations with the user by explaining why the system wants to know certain user information (e.g., initial 20 steps to calibrate and learn the way a user walks) and emphasizing how the answers from the user will help the system perform better over time. This first conversation would help users perceive the system as a kind of social actor that has the ability to learn about its users through the interactions with them.

Intensifying and Integration Stage

After the initial experiences, the participants tried to constantly wear the trackers and regularly engaged with the systems (e.g., logging regular walking when commuting and reviewing daily activities before going to sleep). By doing so, the participants tried to integrate the use of wearable activity trackers into their personal routines. This process also resembled the behaviors people engage in to intensify and integrate relationships with others: spending more time together, disclosing deeper personal information, and blending one's own personality with an intimate relationship.

The Challenge: Imbalanced Returns of Accumulated Data

According to social exchange theories, when people maintain and enhance social relationships, they constantly exchange resources (e.g., information, emotion, goods, and services) and assess of costs and rewards in such exchanges [7, 20]. Similarly, our participants in this stage also expected the reciprocity of transactions with the systems. For example, the participants wanted to get proper feedback, such as acknowledgement of their efforts at maintaining and tracking healthy behaviors and emotional support for future behaviors. Otherwise, they felt the trackers *"did not appreciate"* (F2) their efforts or *"discouraged"* (F1, J3) them from maintaining healthy behaviors.

Also, the participants implicitly assessed the costs and rewards of continuing to use the given activity trackers. One of the significant costs that our participants perceived was the data they accumulated in the systems. As they had continuously shared a significant amount of data with the systems over time, they started to expect a more meaningful return of their data. The excerpt from F2's interview representatively described how this cost-reward mechanism was thought to work: *"I'm trying to keep logging the meal data as much detail as I can because logging more data about me would provide more accurate suggestions to me."*

Like this, as a reward for tracking over time, participants anticipated significant personal relevance in data analysis, rather than absolute numeric representations of their activity data with universal measures. For instance, F2 and J1 wanted the systems to provide a comparison of their status with other people who had similar physical conditions, goals, or lifestyles, which also resonates with the findings from [11]. In addition, F2 hoped the system would learn personalized measures and apply them to give personal nuance to the data interpretation as well as the system intervention, even if it would require a little manual support by her: *"If I can record the step counts during a specific route, for example, from my office to a near cafeteria, I would like to. And I hope the numeric data of my steps to be replaced with 'that unit' when Fitbit suggests something to me. How about saying, 'What about taking a walk to the cafeteria?' instead of just showing how much 'percent' I have to walk more today."*

While the participants who were familiar with technology tried to export, manipulate, and interpret their data by themselves, just like data wranglers [19], for the majority of the other participants, the lack of personal relevance in the analyzed data remarkably affected their further use of the trackers. If a system's feedback was perceived as personally relevant, participants immediately improved their health-related behaviors, for example, by drinking more water (J3), using stairs instead of an elevator (F4), and planning the next meal with healthier food (F2). However, the current systems often behaved without knowledge about the individual users, and this discouraged the participants from maintaining healthy behaviors. F1, for instance, received the alert to charge the device every midnight, a time when she was

always in bed. After she ignored the alerts several times, the tracker finally turned off while she was logging her running record. She was very disappointed with the device, which did not know her "activity timeline." Indeed, J4 quit using the sleep monitoring function after Jawbone *"ruined"* (J4) his sleep log when he traveled to a different time zone.

Design Implication: Developing a Partnership to Accumulate Relevant Knowledge about Users

The issue of meaningful interpretation of activity data, which became apparent in this stage through our analysis, has been also discussed in many related works, suggesting the provision of more actionable and personally relevant data to users [1, 8]. Especially, our perspective on social transactions between users and self-tracking devices suggests that the systems could be designed to explicitly involve their users to incrementally improve the knowledge of the systems so that the systems could become more meaningful to and fit individual users' contexts of use. For example, a user could help a tracker system clarify the meaning of data when an unusual pattern is detected (e.g., unusually sleeping for a very short time on Sunday). If the user clarifies such data as a new routine (e.g., preparing for a class every Monday), the system would prepare to properly support the user to maintain his/her health-related behaviors within the given context of such a routine. By involving users and developing a partnership with them, the systems would be able to accumulate rich contextual knowledge about the users. Also, such systems would empower the users in managing their health life, instead of automatically inferring the meaning of user data or predicting their needs [10].

Stagnation and Termination Stage

The ways of coming apart from activity trackers were also similar to how social relationships decay over time. As time went by, some participants lost their interest in certain features of the systems (which was observable even within the three-week period), and they did not try to explore ways to better use the system anymore; this resembled interpersonal interactions in the stagnation stage. In addition, during the task of uninstalling the device, participants tried to separate their logged data from the devices as much as they could, similar to human behaviors in the termination stage.

The Challenge: Concerns about the Ownership, Accessibility, and Controllability of Personal Data

During the task of uninstallation, the participants tried to separate personal data from the device (i.e., the physical container of the data). However, the participants, and we researchers as well, were surprised at the fact that there was no salient way to initialize or back up personal data from the device (at least at the point of our study). Therefore, participants tried several workarounds that they *believed* were a way to initialize the device. Some of them deleted the mobile application, disconnected the Bluetooth connection with the tracker device, or logged out of the mobile application. For those who could not find such workarounds, we helped them pair their device with our own account, which automatically terminated the connection with the participants' accounts. All of the participants, obviously, expressed strong concerns about the possibility of their data remaining in the device or the possibility of losing their accessibility to and controllability of the data they had accumulated. As a result, these series of experiences elicited users to have distrust toward the systems, even after all the positive experiences of using the services: *"It's like the system says, 'It's free to come join us, but you can't leave us when you want.' It doesn't make sense that I have to send an email to the customer center to delete my own data"* (J2).

Design Implication: Supporting Maintenance of a Trustful and Sound Relationship that Empowers One Another

As the ways of terminating an interpersonal relationship affect future interactions [7], this stage seems to be an important moment for product and service providers to provide a good last impression on their users. Nevertheless, termination has been the most overlooked stage in existing activity tracker systems. Thus, designing an explicit way to reset tracker devices has much room to be improved. There could be many ways of supporting users to manage the ownership of their data at this stage. For instance, users may wish to discard all their data from the service provider or may prefer to leave certain data in the system to improve future service. If users want to leave some of their data in the system, how the data will be abstracted and transmitted should be carefully designed as well.

Meanwhile, designers should know that initializing the data from a tracker device does not always mean that the user wishes to quit maintaining healthy behaviors, as we can learn from the examples of people who were reinforced by their past experiences with activity trackers [5]. To explicitly address this future reinforcement, a system could be designed to provide final messages [7] to users as a form of virtual possession [14]. It may represent the history of a user's health activities and give meaningful access to the full data. It can be used not only to encourage users to sustain their health behaviors, even without the device, but also to smooth the initiation stage with other self-tracking tools by utilizing the data that the user has already accumulated to warm up the cold-start with new devices.

CONCLUSION

We presented a field study on wearable activity trackers and proposed three stages of relationship development between users and self-tracking devices. The results highlighted that users expect a much more sophisticated and personalized system in terms of data analysis and interactions over time. Thus, it will be worthwhile to investigate more about the ways to design interactions between users and self-tracking systems to better support their journey of learning about each other. Finally, our findings could be further studied on other types of emerging self-tracking devices.

ACKNOWLEDGEMENTS

This research was supported by "Dr.M" Project funded by KAIST (N01140095).

REFERENCES

1. Frank Bentley, Konrad Tollmar, Peter Stephenson, Laura Levy, Brian Jones, Scott Robertson, Ed Price, Richard Catrambone, and Jeff Wilson. 2013. Health Mashups: presenting statistical patterns between wellbeing data and context in natural language to promote behavior change. *ACM Transaction on Computer-Human Interaction* 20: 5, Article 30.
2. Eun Kyoung Choe, Nicole B. Lee, Bongshin Lee, Wanda Pratt, and Julie A. Kientz. 2014. Understanding quantified-selfers' practices in collecting and exploring personal data. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '14), 1143-1152.
3. Sunny Consolvo, David W. McDonald, Tammy Toscos, Mike Y. Chen, Jon Froehlich, Beverly Harrison, Predrag Klasnja, Anthony LaMarca, Louis LeGrand, Ryan Libby, Ian Smith, and James A. Landay. 2008. Activity sensing in the wild: a field trial of ubifit garden. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '08), 1797-1806.
4. Brian J. Fogg. 1998. *Charismatic Computers: Creating More Likable and Persuasive Interactive Technologies by Leveraging Principles from Social Psychology.* Ph.D. Dissertation. Stanford University.
5. Thomas Fritz, 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. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '14), 487-496.
6. Lars Hallnäs and Johan Redström. 2001. Slow Technology – Designing for Reflection. *Personal Ubiquitous Computing* 5, 3: 201-212.
7. Mark L. Knapp and Anita L. Vangelisti. 2005. *Interpersonal Communication and Human Relationships* (5th Edition). Pearson.
8. Amanda Lazar, Christian Koehler, Joshua Tanenbaum, and David H. Nguyen. 2015. Why we use and abandon smart devices. In *Proceedings of the ACM International Joint Conference on Pervasive and Ubiquitous Computing* (UbiComp '15), 635-646.
9. Dan Ledger and Daniel McCaffrey. 2014. How the science of human behavior change offers the secret to long-term engagement. Retrieved August 11, 2014 from http://endeavourpartners.net/white-papers/
10. Min Kyung Lee, Junsung Kim, Jodi Forlizzi, and Sara Kiesler. 2015. Personalization revisited: a reflective approach helps people better personalize health services and motivates them to increase physical activity. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (UbiComp '15), 743-754.
11. Yeoreum Lee and Youn-kyung Lim. 2015. Understanding the roles and influences of mediators from multiple social channels for health behavior change. In *Proceedings of the 18th ACM Conference on Computer Supported Cooperative Work & Social Computing* (CSCW '15), 1070-1079.
12. Ian Li, Anind K. Dey, and Jodi Forlizzi. 2011. Understanding my data, myself: supporting self-reflection with ubicomp technologies. In *Proceedings of the 13th international conference on Ubiquitous computing (UbiComp '11)*, 405-414.
13. William T. Odom, Abigail J. Sellen, Richard Banks, David S. Kirk, Tim Regan, Mark Selby, Jodi L. Forlizzi, and John Zimmerman. 2014. Designing for slowness, anticipation and re-visitation: a long term field study of the photobox. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (CHI '14), 1961-1970.
14. William Odom, John Zimmerman, and Jodi Forlizzi. 2010. Virtual possessions. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (DIS '10), 368-371.
15. Byron Reeves and Clifford Nass. 1996. *The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places.* Cambridge University Press.
16. John Rooksby, Mattias Rost, Alistair Morrison, and Matthew Chalmers Chalmers. 2014. Personal tracking as lived informatics. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (CHI '14), 1163-1172.
17. Andrew I. Schein, Alexandrin Popescul, Lyle H. Ungar, and David M. Pennock. 2002. Methods and metrics for cold-start recommendations. In *Proceedings of the ACM SIGIR conference on Research and development in information retrieval* (SIGIR '02), 253–260.
18. Patrick C. Shih, Kyungsik Han, Erika Shehan Poole, Mary Beth Rosson, and John M. Carroll. 2015. Use and Adoption Challenges of Wearable Activity Trackers. In *iConference Proceedings 2015.*
19. Bruce Sterling. 2005. *Shaping Things*. MIT Press.
20. John W. Thibaut and Harold H. Kelly. 1959. *The Social Psychology of Groups.* John Wiley & Sons, Inc.
21. Ana Valencia, Ruth Mugge, Jan Schoormans, and Hendrik Schifferstein. 2015. The design of smart product-service systems (PSSs): An exploration of design characteristics. *International Journal of Design* 9, 1: 13-28.
22. Ron Wakkary, Audrey Desjardins, and Sabrina Hauser. 2015. Unselfconscious Interaction: A Conceptual Construct. *Interacting with Computers*, first published online July 17, 2015. doi:10.1093/iwc/iwv018