FITNESS TRACKERS:

UNDERSTANDING HOW USER EXPERIENCE IMPACTS MOTIVATION

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Chapter 1: Introduction

Wearable technology has become increasingly popular, and devices range from headsets, glasses, clothing, shoes, and jewelry. Wearable computing dates back to the 1960s, when militaries began developing headgear for aviators in combat. Emperador (2014) offers an inventory on the history of wearables and notes that in 1979, Sony released the Walkman, which was highly regarded as the first wearable computer. This trend continued into the early 1980s, when Steven Mann – widely considered a pioneer of wearable computing – invented a backpack-mounted computer that controlled photographic equipment. Following the backpack, Mann invented a headset in 1994 that transmitted images to the web. By 2001, IBM had developed a wristwatch computer known as Watchpad.

Wearables have evolved from military use and simple music applications like the Walkman, to present-day technologies like sensors in fitness trackers and voice-activated devices like Google Glass. Although there are several options for wearable technology, among the most popular are wrist-worn fitness trackers and smartwatches. The International Data Corporation's wearables team found that in 2016, smart wearables had most of the share of the wearable market. These smart wearables take the form of watches and use fitness tracking features (IDC, 2017). In particular, wrist-worn Fitness trackers such as Fitbit, Garmin, and Apple Watch have saturated the wearable market, which necessitates deeper research about the fitness tracker user experience. Thus, this thesis explores how usability, design, and social features provided by fitness trackers affect the user experience, as well as factors that lead to long-term adoption or abandonment of devices.

Fitness trackers provide users the opportunity to monitor their lifestyles and physical activities through visual representations, as well as provide ubiquitous connectivity to their health (Yli-Kauhaluoma & Pantzar, 2018). In the United States, obesity is a growing public health issue. There are many benefits to being physically fit, including managing weight, and fitness trackers may motivate users to improve their physical wellbeing. Fitness trackers are popular because they track specific data, such as heart rate, steps taken, sleep, and calories burned. Trackers generate quantitative data that shows individuals how their health is improving and allows them to hold themselves accountable. Within the wrist-worn fitness tracker market, styles, capabilities, and cost may vary widely or have very few differences which may become overwhelming for users trying to purchase a device. However, The disadvantage is that the wearable market is oversaturated with many different brands, styles, and features for fitness trackers.

The popularity of these devices coincides with the growing quantified self movement, a social movement in which people use fitness trackers to log and track personal health information daily. Also known as life-logging or personal informatics, it involves gathering data to determine individual behaviors, feelings, and regular habits (Lupton, 2014). This suggests that the experience of using a fitness tracker is social in nature, as individuals can share their data with others.

Furthermore, current research focuses on functionality and design of fitness trackers. For example, studies have identified that functionality and design play a key role in the fitness tracker experience. Tao (2007) found comfort and size may also be driving factors related to why users choose to wear a particular brand or type of fitness tracker. Lupton (2014) argues that the

design should be an extension of a person's style and personality. If it does not fit those criteria, the appearance of the wearable can make users feel self-conscious about how others perceive them, which may affect them socially.

Ultimately, fitness trackers represent the most popular smart wearable technology on the market (IDC, 2017). However, Lazar *et al*. (2015) found that 80% of participants abandoned their devices and thus did not develop any routine for self-tracking. However, those that kept the devices developed a routine and found the devices useful. Yet, few studies have evaluated the fitness tracker user experience. Rather, studies have focused on the functionality and usability of the designs (Dunne, 2011). Studying usability sheds light on how users interact with devices and designs, but fails to understand how users are encouraged to incorporate fitness trackers into their daily routines. This approach neglects to understand and address what factors cause consumers quickly purchase and/or subsequently abandon their devices.

However, studies have found that, the novelty of fitness tracker devices often wears off over time (Fritz *et al*., 2014); some devices are inaccurate when it comes to tracking certain features (Schlögl *et al*., 2015); data provided by devices is often misunderstood by users (Lazar *et al*., 2015); and device maintenance – such as the frequent need to charge – can negative affect the user experience (Lazar *et al*., 2015). Fritz *et al*. (2014) discovered that over time, users either develop routines and become less interested in their devices, or the feedback provided by devices was no longer interesting. In these cases, the novelty of a device can be lost. Schlögl *et al*. (2015) noted that in their study, there was a discrepancy of step counts between two different devices, which led users to believe the devices were inaccurate and thus, lost trust in the device. Finally, Lazar *et al*. (2015) found that users perceived the data to be incorrect or that the data did not fit

users' perceived self image. For example, users believed they were more active than the device reported and perceived data associated with this metric negatively or less-than-helpful. Alternatively, they also perceived that the data was trying to make them feel guilty. While the data may not be inaccurate, users often believe the fitness tracker does not accurately report the activity they completed for a given day. Finally, Lazar *et al*. revealed that participants often felt that device maintenance, such as charging and cleaning the device, became too much of a chore and thus, abandoned their devices.

However, none of these researchers provided an in-depth exploration of a robust and comprehensive set of factors that affect users' long-term use of fitness trackers. Although most studies acknowledge that a combination of issues are at play, they often leave these items underexplored. For example, few studies have evaluated what elements create a positive perception of the user experience of fitness trackers. Other researchers have identified this gap and suggest that due to the ubiquitous nature of the experience, device research should engage users more deeply to discover how users interact with the devices naturally in the situations for which fitness trackers are designed. To engage users more deeply, researchers recommend that those who choose to study the experience of fitness trackers should encourage users to adopt fitness trackers for an extended period of time such as Schlögl *et al.* (2015) Fritz *et al.* (2014) and Yli-Kauhaluoma and Pantzar (2018). For example, because fitness trackers are intended to help monitor and motivate users to improve their physical health, asking users to log their daily usage of fitness trackers can help researchers better understand the extent to which users' goals are being met by device features. Moreover, a diary study that requires participants to track their use of a device over six weeks allows them to develop a routine of use that can result in more

robust and/or valuable feedback about the user experience. Additionally, understanding the fitness tracker user experience will also ensure that product makers and designers better understand the specific features (or lack thereof) that directly relate to long-term adoption or abandonment of these devices.

Thus, this thesis aims to 1) understand how the usability, design, and social features provided by fitness trackers affects the user experience, 2) which of these factors drive users toward long-term adoption or abandonment of their devices, 3) provide recommendations for fitness tracker designers and product developers to improve the user experience. To achieve these goals, a diary study, survey, and semi-structured interviews were designed to address two research questions:

> **RQ1:** What user experience factors contribute to increased motivation for users to be more physically active?
>
> **RQ2:** What specific aspects of the user experience drive users toward long-term adoption or abandonment of their devices?
>
> **RQ3:** What key requirements exist for fitness tracker designers and product developers to improve the user experience?

Based on prior research about fitness trackers in general, this thesis hypothesizes the following for the above research questions:

> **H1:** The following factors contribute to users' motivation to adopt and continue to use fitness tracking devices: social components such as life logging or sharing data with friends, usability such as ease of use when interacting with data, and information design.
>
> **H2:** The following factors lead to device abandonment: appearance of the device, social components, usability errors, and device novelty.
>
> **H3:** There are a number of essential features that fitness trackers must include in order to provide a positive user experience: heart rate monitor, goal setting functionality, easy to learn and use, customizable and fashionable design.

This thesis makes three key contributions to our understanding of the fitness tracker user experience: 1) findings from this study should lead to stronger user experiences; 2) help researchers and developers better understand why fitness trackers are important to their users; and 3) illuminate how the devices are positioned within the growing fitness industry. Understanding the experience users have with trackers is important because the fitness industry is becoming more popular, the wearable and quantified-self movement is coming of age, and the fitness tracker market is oversaturated with inconsistently designed devices from a multitude of different companies. The health and fitness industry is currently thriving in the United States. In the U.S., there are more than 50 million registered health club members, not including smaller fitness clubs or boutique fitness studios. The U.S. increased its revenue in the fitness industry 7.2% within one year, with predictions that 2018 would see 87.5 billion dollars of revenue (Fitness Industry Statistics, 2017). Additionally, Nielsen found in 2014 that 81% of millenials are either working out or would like to. Unsurprisingly, this number has led businesses to market gyms and fitness trackers more to this demographic.

Furthermore, fitness trackers are currently one of the most popular tools used in physical fitness. The American College of Sports medicine found in a survey that wearables are the third most popular trend for individuals who are physically active or striving to be more physically active (Fitness Trends, 2018). This trend is more popular than strength training, yoga, and personal training. Many individuals are using these devices to measure their biometric data. The quantified self movement is ideal in conjunction with the use of fitness trackers. With the growing popularity of gym memberships, fitness trackers give individuals the opportunity to see their progress, such as calories or heart rate, in real time. The popularity of these devices can be

seen at a gym or on college campuses. Understanding why the fitness tracker and quantified self movement is popular in the fitness industry provides understanding as to why there are a multitude of options within the fitness tracker market.

Finally, this thesis is important because the popularity of fitness tracking devices has led to an over-saturated market. Within the market, different brands have similar appearances, but users experience these devices differently. Additionally, these devices are inconsistent in feature offerings and accuracy. Nearly all devices are designed to be worn on the wrist and function as a watch in conjunction with its fitness tracking features. Devices are similar in color, appearance, style, and features. Although consistent with most offerings, devices have varying user experiences. Despite the similarities many of these smart fitness tracking devices share, the cost associated with these devices varies greatly. With few differences, users are confused and unsure which device will best suit their needs. In addition to the similarities, some devices have several differences in their capabilities and there is not always a consistent interaction design per device.

The remainder of this thesis is structured as follows: Chapter 2 provides a review of literature to understand the current state of fitness tracking technology and research that has already been done in this field. Chapter 3 outlines the methods to evaluate the hypothesis. It will outline a six-week user experience evaluation of the Fitbit Charge 2 in an effort to discover how self-tracking, design, and usability affect user perceptions of their devices. Additionally, it attempts to discover whether social interactions affect users' desire to form a routine by adopting a fitness tracker. In addition to the diary study, interviews were conducted to understand the context in which participants use the Fitbit. A survey was used to compare attitudes of users who use a fitness tracker and those who abandoned their fitness trackers. Chapter 4 reports the results

from the survey, diary, and interviews. Finally, Chapter 5 discusses the underlying meaning of the results, possible implications in other areas of research, and the possible improvements that can be made in designing fitness tracker experiences.

Chapter 2: Literature Review

This literature review draws from research in three key areas: 1) how fitness trackers aid in physical fitness, 2) user motivation to use fitness trackers, and 3) studies that have tested wearables in the wild.

How fitness trackers aid in physical fitness

Fitness trackers collect data, such as heart rate and calories, through sensors. These types of data are collected while users complete any variety of physical activities. In a journal article to provide distinction between definitions of physical activity and physical fitness for health related research Caspersen, Powell, and Christenson (1985) wrote that physical activity means a person is moving their body in a way that causes their skeletal muscles to spend energy. For example, this could be either by exercising at the gym, running a 5k, cycling, or playing sports. Alternatively, physical fitness is different refers to a set of attributes that people have or achieve. These attributes could be cardiorespiratory endurance, muscular endurance, muscular strength, body composition, or flexibility (Caspersen *et al*., 1985). By motivating users to regularly complete physical activities, wearables can aid in improving physical fitness.

Knowing what kinds of feedback users receive from activity trackers helps to understand how they can lead to improving physical activity. Some wearables also use GPS to provide more contextual information about the physical activity being performed. This contextual information determines, where, when, and how the activity was completed. The data from the wearable aids in providing more accurate feedback for wearable devices (Butte *et al*., 2012). Due to the sensors used by the trackers, they are are often considered to be context-aware. Context-aware devices

can sense the environment and provide feedback on that environment. For example, some Garmin devices can determine the type of activity the user is completing based on their body movements (Garmin, 2017).

Wearables provide feedback to users in two ways. Feedback is provided through the interface and through the application the wearable is paired with via the user's phone. That tells the user their data for any particular day or time. Providing data (such as heart rate) can help users manage their fitness activity, like informing the user if his or her heart rate is too high or too low. This is the main mode of communication from the wearable to the human that aids individuals in their quest to improve their physical health. Altenhoff, Vaigneur, and Caine (2015) evaluated the usage of the wearable and its application and found that the most useful feedback users got was from the application. The application gave more detailed information and feedback than can be displayed on the small watch face. For example, the Garmin Connect app shows the user comparative details such as comparing their current day to a previous day. The authors argue that wearables' ability to aid users depends on the presentation of data through the tracker and its application (Altenhoff *et al*., 2015).

Fitness Trackers and User Experience

"User experience" can be difficult to define, as it is used in many different contexts. The term was coined by Don Norman while he was the Vice President of the Advanced Technology Group at Apple. Norman, who is regarded as one of the pioneers of user experience, said in an interview, "I invented the term because I thought human interface and usability were too narrow. I wanted to cover all aspects of the person's experience with the system including industrial design graphics, the interface, the physical interaction and the manual. Since then the term has

spread widely, so much so that it is starting to lose it's meaning" (Merholz, 2007), In the interview Norman also elaborated saying, "user experience covers all things, usability, human centered design, and affordances" (2007). How the user experiences or feels about an object is personal. Designing for experience ensures that all aspects of the product, marketing, purchase, design, and using the product, incite positive feelings rather than frustrating feelings from the user (Norman, 2013). A second example of how to understand the concept of user experience is defined Jesse Garrett's book, *The Elements of User Experience: User-Centered Design for the Web and Beyond*. In Garrett's book (2011), his example states the following:

> User experience design often deals with questions of context. Aesthetic design makes sure the button on the coffee maker is an appealing shape and texture. Functional design makes sure it triggers the appropriate action on the device. User experience design makes sure the aesthetic and functional aspects of the button work in the context of the rest of the product, asking questions like, "Is the button too small for such an important function?" User experience design also makes sure the button works in the context of what the user is trying to accomplish, asking other questions like, "Is the button in the right place relative to the other controls the user would be using at the same time?" (2011, p. 50).

User experience is important for understanding how users interact with the design and functionality of an item. Whether that technology is as simple as a pencil, how users remember their interactions with it is important, because if the user is having a negative experience, they are unlikely to continue using that device. In context with a fitness tracker, if the user is having a negative experience or has negative feelings towards their device, they are unlikely to adopt the device for long-term use.

Wearables are uniquely affected by the user experience in that wearables are used on the body and are constantly monitoring biometric data and users elect to engage in this experience on their own free will. Due to their nature, the experience of using a fitness trackers requires

users to always wear their device. The instantaneous feedback provided is the key part of the experience. When the wearer wants to know their steps or heart rate, they interact with the device to view the data at their convenience. Being able to understand the feedback and feel comfortable wearing the device at all times asks the user to in some ways change their lifestyle. This type of experience with a device is unique because it helps aid users during specific exercise activities and may contribute to the development of routines.

Most good designs should have affordances. "An affordance is a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used" (Norman, 2013, p. 13). For example, wrist worn fitness trackers are designed in such a way that is meant to fit on the user's wrist or affords wearing on the wrist.

Some wearables are meant to be worn at all times, and they should be designed in such a way that they are small, robust, consume little power, and be pleasant to wear. Some fitness tracking wearables track sleep and are water resistant so that they may be worn in the shower or bath if the user chooses. Although not all wearables have this functionality, many of the popular fitness trackers have this capability. For users to be comfortable wearing fitness trackers, they must be small, robust, consume little power, and be pleasant to wear. These are some of the key requirements in designing a wearable for users (Tao, 2007). In this manner, the design matters because the level of comfort it provides to the user may encourage or discourage them to consistently use their device.

Usability is an important factor in the experience of using an activity tracker. Researchers conduct usability tests with the devices as some individuals cite usability issues as a reason for the device failing to motivate them to change their behavior (Lowens, Motti, and Caine, 2015).

One usability study found that users who employ fitness tracking devices in their lives were concerned with the accuracy of the feedback the device provided. Inaccurate data occurs when users begin to sweat and the device loses contact with the skin. Once this happens, it no longer tracks their activity and thus does not help them towards their fitness goals. Additionally, some fitness trackers rely on movement from the user's wrist. These types of trackers do not track accurately if the user is not swinging their wrist. This requires a specific movement that is not always natural for the user to do (Lowens, Motti, and Caine, 2015). Moreover, some users complain that they don't trust the device because they can just swing their wrist or shake the device while they are sitting down and essentially "cheat." Users choose to do this to make it appear that they did more than the device reports because they believe the device is incorrect. These types of usability issues of certain devices results in user's not trusting their devices. It also shows the need for device algorithms to be more accurate in responding to the user's movements so there is no need to move a specific way.

User motivation to use fitness trackers

Fitness trackers have become the most popular type of wearable to track physical activities; however, there is some question as to how users are motivated by these devices. Fritz, Huang, Murphy and Zimmerman (2014) conducted a study that focused on why users choose to use a wearable device. Their study evaluated those who adopted their tracker for three months or longer in order to understand how the users were motivated by these devices. In this study they uncover how fitness trackers can persuade or motivate users to improve their physical fitness through long term adoption.

The results showed that many users felt some internal motivation to be better, and thus bought a fitness tracker to help them improve their lifestyle. One participant stated, "In my case, what I wanted to understand really was, well, how much I was actually walking per day. I had been in rehab since an auto accident... this was part of... trying to learn and get a better feel for just how much I was generally being active during the day" (Fritz *et al*., 2014, p. 491). There needs to be some kind of initial motivation for the wearers to even be interested in purchasing or using a fitness tracker.

The research Fritz *et al*. (2014) conducted found that users were motivated by the data and feedback the activity trackers gave them. Another participant, discussing their brand of fitness tracker, the FuelBand, stated, "I got [my FuelBand] precisely to motivate me to be a bit more active" (Fritz *et al*., p. 491). The same research conducted by Fritz *et al*. (2014) discovered that over time, the novelty of the device began to wear off for some users, but its presence still had some motivational effects. Many participants remarked that after a certain amount of time, they knew their habits and knew about how many steps they did in a normal day (Fritz *et al*. 2014).

The study conducted by Fritz, *et al*. (2014) reveals that many users must have some sort of initial motivation to purchase and use a wearable device. Once the user has purchased the device, the data and feedback the device gives the users, such as steps taken during a day, motivates them to create a routine. They begin to recognize when they have reached their step goal without viewing the data from their tracker. The device acts as a safeguard to ensure their daily goals are met (Fritz *et al*., 2014).

One theory that describes what motivates users to use fitness tracking wearables is *self-tracking.* Self-tracking, or quantified self, has recently become popular among those who wish to improve their lifestyles by tracking their daily routines and attempt to understand or improve those routines (Lupton, 2014). Lupton's (2014) research suggests that self-tracking should be thought of more as a social change rather than a psychological or cognitive approach. Lupton found that there are two parts of self-tracking, self optimization and governing the self. Self optimization refers to the data people receive from a tracker. For example, they might say, "My goal is to get 100 more steps today than I did yesterday." When the user sees the data, and the numbers show they have not yet met their goal, they feel they are improving their physical well-being by accomplishing their goal. Second, self-tracking helps people feel more in control of their lives. They govern themselves by assigning responsibilities related to their health that the fitness tracker can report on (Lupton, 2014).

Additional studies have also been conducted to understand whether wearables successfully leverage self-tracking and self-quantification to motivate behavior change in users. To evaluate if wearables implement any behavior change techniques, the study had participants use a device over the course of one week. The research found that the most successful technique for initiating behavior change in users was self-monitoring or self-tracking techniques. These techniques track health informatics such as heart rate, steps, and calories. From this data, users are motivated to improve their physical health (Mercer, Li, Giangregorio, Burns & Grindrod, 2016).

Self-tracking is a social movement, making social aspects part of the experience. Many fitness trackers allow users to connect with friends to compare data, often called challenges.

During a step challenge, users are rewarded badges for various successes. The person with the most steps overall in the challenge, person with the most steps in a day, and even the person with the least amount of steps all receive badges. This concept rewards users for their achievements, but also motivates those that did not do as well as their friends (Fritz *et al.*, 2014). Additionally, this is an example of gamification within an experience that is not traditionally considered to be a game.

This social layer of self-tracking also provides an opportunity for play within the experience. Gamification was deployed by designers of self-tracking systems and may be done either as a single player or multiplayer, depending on how users choose to share their data. Sociologist Roger Caillois (1961) defines play into different categories and states that within these categories, play may be more or less regulated (p. 36). This concept helps to understand the type of play encouraged by fitness trackers. Fitness trackers encourage single or multiplayer gameplay, with loosely structured rules, in a competitive fashion. Single player gameplay might refer to users trying to "beat" their steps from the day before, or improving their data in some way. In competing with themselves users might become more motivated. Users can also compete with others by engaging in weekly competitions to see who gets the most steps. Sharing this data might encourage users to do more because their data is visible to others and they could be motivated to "beat" their friends by exercising or walking more frequently.

Authors have also argued that gamification can make everyday tasks, such as creating a healthy lifestyle through self-tracking, more enjoyable and makes users feel that they are making more progress (Whitson, 2013). In a case study on self-surveying gamified applications, Whitson (2013) finds that self-tracking is embraced as play because of the participatory nature of

self-tracking. Users who self-track have done so willingly and thus the element of play is injected to make otherwise monotonous activities, such as daily exercise. Caillois (1961) also argues that play should be entered freely and also players are done they should be able to leave.

The social component of the self-tracking movement and gamification may also lead to device abandonment. Though self-tracking is voluntary, because of the social narrative, individuals may feel coerced to improve their lifestyles. When individuals are successful, they are rewarded and praised for doing so. When individuals fail, they face moral judgement from their peers (Lupton, 2014). Gamification may also fail due to the ubiquitous nature of fitness trackers. Fitness trackers are meant to be worn daily, thus not allowing users to freely turn off the device or leave the play. Whitson (2013) argues this layer of play with self-tracking might discourage users because there is an expectation that users are unable to choose whether or not they continue to participate.

Testing wearables in the wild

Schlögl *et al.* (2015) conducted a study to understand the context in which wearables are used. In their review of previous literature, they found that despite the growing popularity of wearables in everyday life, an understanding of how users interact with wearables is still somewhat under-explored. They discovered a lack of information and feedback from the businesses that make the wearables. These businesses do not provide details such as who uses them or how they are used. Similarly, there is a lack of feedback from individuals on the interactions they have with wearables in real-world settings. Rather, the feedback comes from controlled settings focused on functionality and usability. Therefore, the research concluded there is a need to test these particular devices *in the wild* (Schlögl *et al.*, 2015).

Testing wearables in their natural environment provides a better understanding of how users interact with these devices on a daily basis. Because of the mobility and flexibility of a wearable, it can be used in many different contexts and situations. Though two people might use an activity tracker, the users might utilize these activity trackers in different ways (Lyons & Starner, 2001). A smartwatch and activity tracker both have the ability to track physical fitness, however, a smartwatch offers features outside of fitness related applications and thus will be used differently than a fitness tracker.

Due to the many different uses of wearables and features offered, even among similar wrist-worn devices, there is a need to test these devices in their natural environment. Testing the devices while they are being used in their intended space allows researchers to gather specific attitudes from the user such as how much the user employs the device, where they employ the device, and how the device impacts their daily activities. This information allows us to understand user attitudes and how we can better improve the experience and usability of these devices that may go unnoticed in a survey. A study by Schlögl *et al*. (2015) allows for a better understanding of the challenges of current wearable technology being sold. They conducted two studies, one with smartwatches and the other with activity trackers. For each study, users were given their respective wearable for a week and then asked to report on their particular device.

In one study on smart watches, twelve participants were given a Samsung Galaxy Gear 2 smartwatch and were asked to report their experience. During the duration of the week, users reported complaints such as weak battery life and that the watch did not store things how the Samsung Galaxy phone would, making it difficult to complete tasks. Participants of the fitness activity tracker study were given Jawbone Up Fitness bracelets. Throughout the course of the

week, these users reported the design was uncomfortable, which made it difficult to sleep and therefore affected the tracker's ability to report on the user's hours slept. Users of the fitness bracelet also questioned the accuracy of the data reported by the bracelet. They also complained that certain features, such as tracking eating habits, were not implemented well and while it was useful, was also too difficult to use (Schlögl *et al*., 2015).

This study found that there is a need for real-life user studies to understand the challenges and possibilities that may arise in wearable technologies. They found a need to study wearables from a user-centered design approach to develop a better understanding of the design space to improve these wearables (Schlögl *et al*., 2015). Testing how users interact with wearables and their experiences is a key factor in understanding how wearables might motivate users to improve their overall physical fitness and health.

Lazar *et al*. (2015) study found that while fitness trackers are a popular purchase, users are quick to abandon their devices. This study asked participants to choose their personal tracking device to achieve their goals. When participants abandoned the devices, the study found it was because they thought the data provided was not useful, it did not fit perceptions of themselves, and because the device required regular maintenance. Users thought the data was not useful because they did not understand the feedback coming from the device. The numbers regarding heart rate and steps taken did not feel relevant to their goals. Users also said that the data did not feel correct because they had a different perception of themselves than what the device showed. For example, users thought they took more steps in a day than what the device told them. Users also found maintenance required them to frequently charge their devices overnight, and then they would forget to put it back on in the morning (Lazar *et al*, 2015).

Aspects of the user experience, such as design, social impacts, and usability, may be some of the driving factors that cause users to abandon their tracking devices. This research shows that when users are successful in changing their habits with these devices, their overall attitude is more positive about the experience. By comparing the attitudes of those who are successful and those who abandon their devices, it is possible to begin to study the user experience and uncover how the experience can be improved so that more users will adopt fitness trackers long-term. A question left out of literature is understanding how the experience fails to keep users engaged with their the device. The methods in the following chapter seek to discover which specific aspects of the user experience lead to device abandonment and which pieces of the experience are the strongest.

Chapter 3: Methodology

This study employed a mixed-methods approach that included three main activities. First, a survey of current or previous owners of wrist-worn fitness trackers compared attitudes about how current and previous users felt about the experience with their device. Second, a six-week diary study documented daily use and activities for twelve new users of the Fitbit Charge 2, the most popular wrist-worn device on the market at the time of the study. Third, exit interviews with diary participants allowed for semi-structured inquiry about the overall user experience with the device. The following sections chronicle the procedures followed for each of these research activities.

Fitness Tracker Survey

A survey was employed to understand user perceptions of their fitness tracker. The survey compared attitudes of current and past users of fitness tracking devices. The questions were designed to gauge how users feel about their experiences, what features were the most helpful, and why they chose to continue using the device or not. The questions also aimed to understand what did or did not contribute to a positive user experience of the fitness tracking device.

Survey Design

The user survey included 14 questions (Appendix A) and was intended for individuals who actively uses a fitness tracking device, as well as those who had previously used a device. After identifying the type of device the respondent uses (or had used in the past), participants were asked complete daily entries about how the device did or did not motivate them to engage in physical activity, how they interacted with the device, what features they did or did not enjoy,

and general feelings towards it. The questions were a mix of nine multiple choice questions and five open-ended questions. All participants were given 10 (Appendix A) questions on a five point Likert scale from strongly agree to strongly disagree to understand users' attitudes toward fitness trackers. The survey intended to gauge how effective users found the trackers to be in motivating them to be physically active, how usable the device was, and their feelings towards the device. The survey also aimed to discover how participants use their devices, as well as what they like or dislike about their devices. It asked users whether they have used multiple devices and why they changed their devices to understand which experiences were more desirable. The goal is to understand why users abandon their devices or continue to use them long term.

Participants

Males and females between 18 and 65 years old were recruited to participate in this study. The most common age range that owns fitness trackers are between the ages 18-65 (Riley, 2015). Participants were recruited via email through the Ball State University email communication center. The requirements to complete the survey were the participant must be currently using or previously used a wrist-worn fitness tracking device.

Analysis

Analysis of open-ended survey questions included the development of a coding schema designed to illuminate common themes and opinions about users' wrist worn fitness tracker. Each unit of analysis was assigned a code to again represent a summative, salient, and/or essence-capturing attribute (Saldana, 2009). The coding schema was developed by analyzing qualitative answers to survey questions. Qualitative answers were analyzed for complete statements. Complete statements included an essence-capturing attribute of the experience,

features, or design. These statements were then grouped by similarity of topic. Statements were recorded and counted for the number of statements made, and color coded by the participants that made the statements (Figure 1). Statements that were irrelevant to this study — i.e., "I don't have a response," or "I don't know." — were eliminated from the dataset.

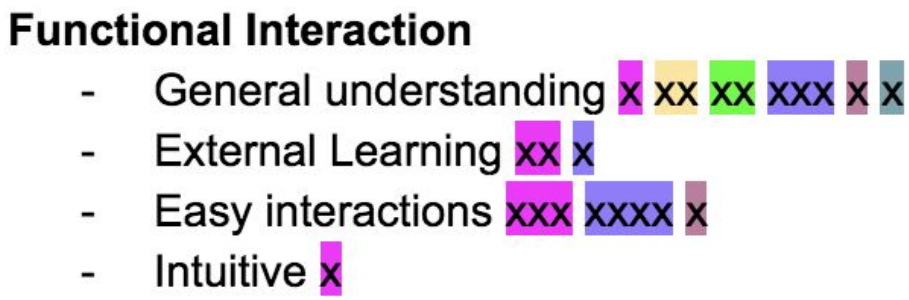

Figure 1. Example of coding schema development

Additionally, a comparative analysis was conducted on answers to Likert-scale questions based on the type of device participants indicated they use, as well as how frequently they reported that they exercise. These grouping were then compared on three main dimensions: usability, user perceptions, and user motivation.

Diary Evaluation

Participants were asked to use a Fitbit Charge 2 for a period of six weeks, during which they self-reported their usage of the device in a diary. They reported on the context of how they used the device, whether it motivated them, and physical activities they recorded for any given day. In the event the participant did not wear the device, they were asked to report why they did not. They were asked to use it as they would normally, so the possibility that they may not wear the device or quit using the device was accounted for in the instructions. Although most research states that a habit is formed in 21 days (Kaushal, Rhodes, Meldrum, & Spence, 2017), some have argued that more complex activities, such as improving physical health, take longer. In their

research on habits, Kaushal *et al*. (2017) found that creating a routine of completing physical activities may take anywhere from four to six weeks, and can sometimes take longer. Their research showed that making simple tasks into habits, such as drinking water every day, could be done in 21 days. However, more complex habits, such as creating a workout routine, took anywhere from four to six weeks.

A diary usability evaluation is recommended for studies that last longer than four weeks by the Nielsen Norman Group (Flaherty, 2016). They note that diaries provide contextual real-time insights. The data is self-reported by the users and helps to understand habits, usage, attitudes and motivations, and changes in behavior. In particular, this diary aims to understand the user's habits, motivations, and any changes in behavior that occur by using the device.

Apparatus Technology Used

This study used the Fitbit Charge 2 for the diary usability study. Fitbit has consistently sold the most wearables in the United States in the past three years based on quarterly sales and holds the most market share of the top five wearables (IDC, 2017). Selling their devices in over 55,000 retail stores in 65 countries, Fitbit's mission is to "...help people lead healthier, more active lives by empowering them with data, inspiration, and guidance to reach their goals" (Fitbit, 2017).

Since 2014, Fitbit has more than doubled their total devices sold as well as tripled their amount of active users (Fitbit, 2017). In the company's annual report, it is reported than in 2016, they sold a total of 22,295 devices and had 23,238 active users. (Fitbit, 2017). Fitbit states in their 2016 annual report that "Devices sold represents the number of connected health and fitness

devices that are sold during a period, net of expected returns and provisions for the Fitbit Force recall." The company also defines active users as follows:

> A registered Fitbit user who, within the three months prior to the date of measurement, has (a) an active Fitbit Premium or FitStar subscription, (b) paired a health and fitness tracker or Aria scale with his or her Fitbit account, or (c) logged at least 100 steps with a health and fitness tracker or a weight measurement using an Aria scale. The number of active users is based on subscription and device activity associated with each Fitbit user account and, accordingly, a user with multiple devices synced to his or her Fitbit account is counted as only one active user regardless of the number of devices that such user syncs to the account (Fitbit, 2017).

The measurement of active users allows Fitbit to assess the growth of the Fitbit community, but does not directly correlate or influence their revenue.

Due to the substantial power Fitbit has over the wearable market, it is important to understand why so many users continue to choose Fitbit. With so many active users in the 2016 fiscal year it is important to understand why Fitbit is the top choice for fitness trackers and if their experience differs from others. In understanding the experience of wearing a Fitbit, the diary study provides context for the experience.

Participants

The criteria for participating in the diary study was that participants must be 18 or older, and never worn or used a wrist-worn fitness tracker for any period of time. They were chosen based on availability and on a first-response basis. There were twelve participants for the diary study. Participants were male and female and ranged from ages 19-41.

Exit Interviews

Users were interviewed at the end of their diary study as recommended by the Nielsen Norman Group (Flaherty, 2016). The interviews covered how users felt about using the device, and further uncovered the context in which the devices were used. For participants who did not

consistently wear the device, the interviews provided a better understanding of what issues within the experience caused them to not wear their device consistently.

Diary and Exit Interview Analysis

Diaries and exit interviews were analyzed in a similar fashion to the qualitative survey questions. The analysis included the development of a coding schema designed to illuminate common themes, opinions, and problems documented in the diaries. Statements made in the diaries and interviews were analyzed and grouped by similar statements. They were then grouped and the number of statements and percentage occurrence for each statement was calculated from the total statements made. Statements that were irrelevant to this study — i.e., "I don't have a response," or "I don't know." — were eliminated from the dataset. The following chapter outlines and reports the results from the survey, diary, and exit interviews.

Chapter 4: Results

Survey

A total of 537 survey responses were collected, with 117 eliminated from the dataset because they were were invalid or incomplete. This left a total of 420 respondents.

Survey Demographics

Of those who identified (n=333), respondents were female, (n=83) male, and five (n=5) non-binary/third gender. More than half of all respondents (n=222) who indicated their age reported being between 18-24 years old (Figure 2).

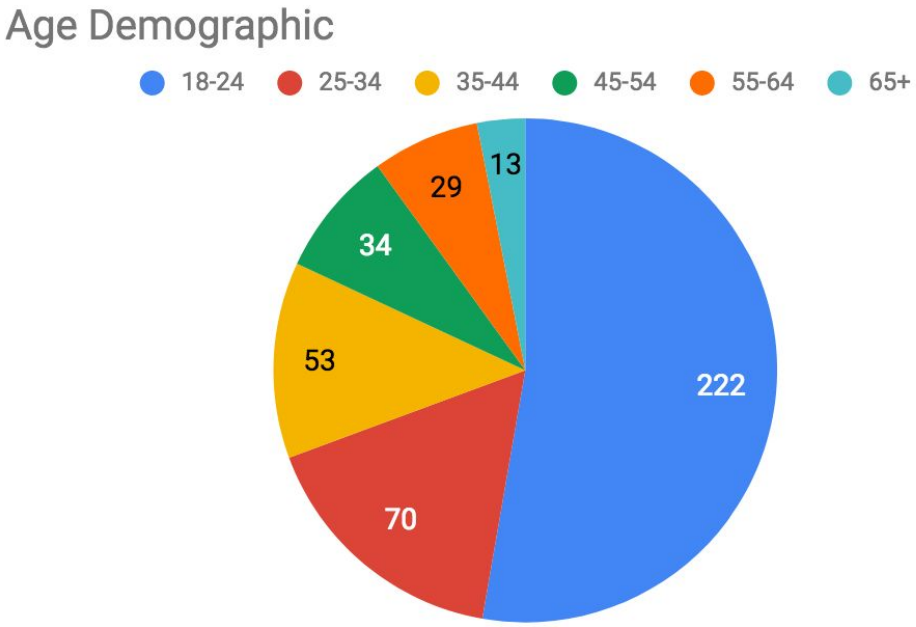

Figure 2. Age Demographic of survey responses

Respondents also indicated the frequency with which they work out. More than half (n=218) indicated they workout three to five days a week. The second most frequent response was one to two days a week (n=113), followed by more than five days a week (n=61) and never (n=28) (Figure 3).

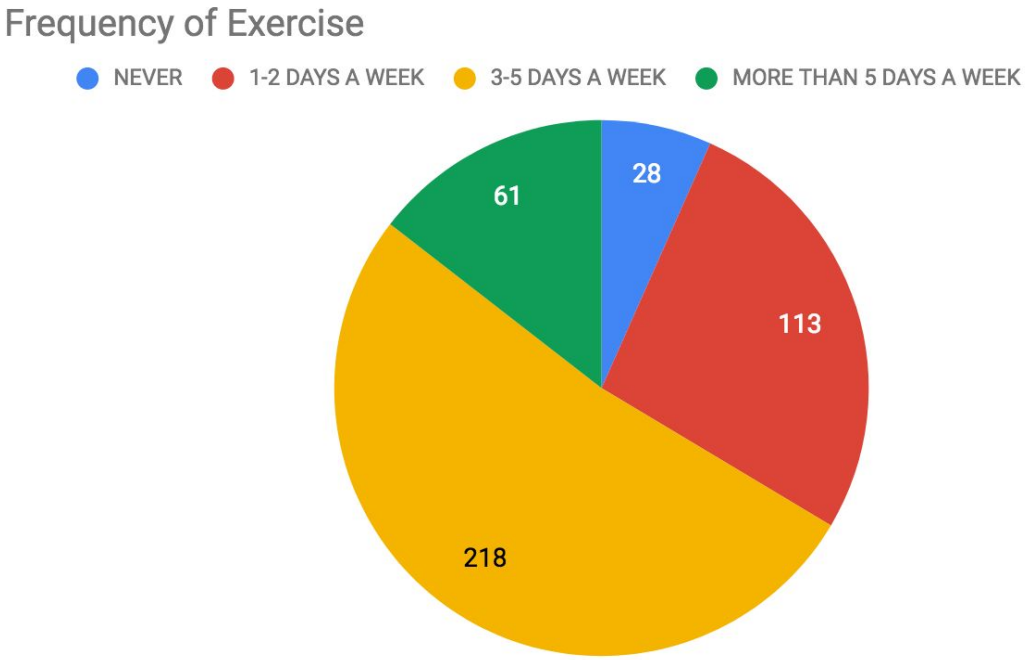

Figure 3. Frequency of Exercise

More than half (n=360) participants reported they currently use a fitness tracking device, while 60 indicated they are not currently using a fitness tracking device but had previously used one.

Survey Results

The majority of participants who identified as current users own Fitbits (n=213). The second most popular device was Apple Watch (n=95), followed by Garmin (n=29), Samsung Gear (n=12), and other devices (n=11). Previous users followed a similar trend. The majority of previous owners (n=41) also used Fitbits. The second most popular device was other (n=10), followed by Garmin (n=5), and Apple Watch (n=4). No previous users owned a Samsung Gear (Figure 4).

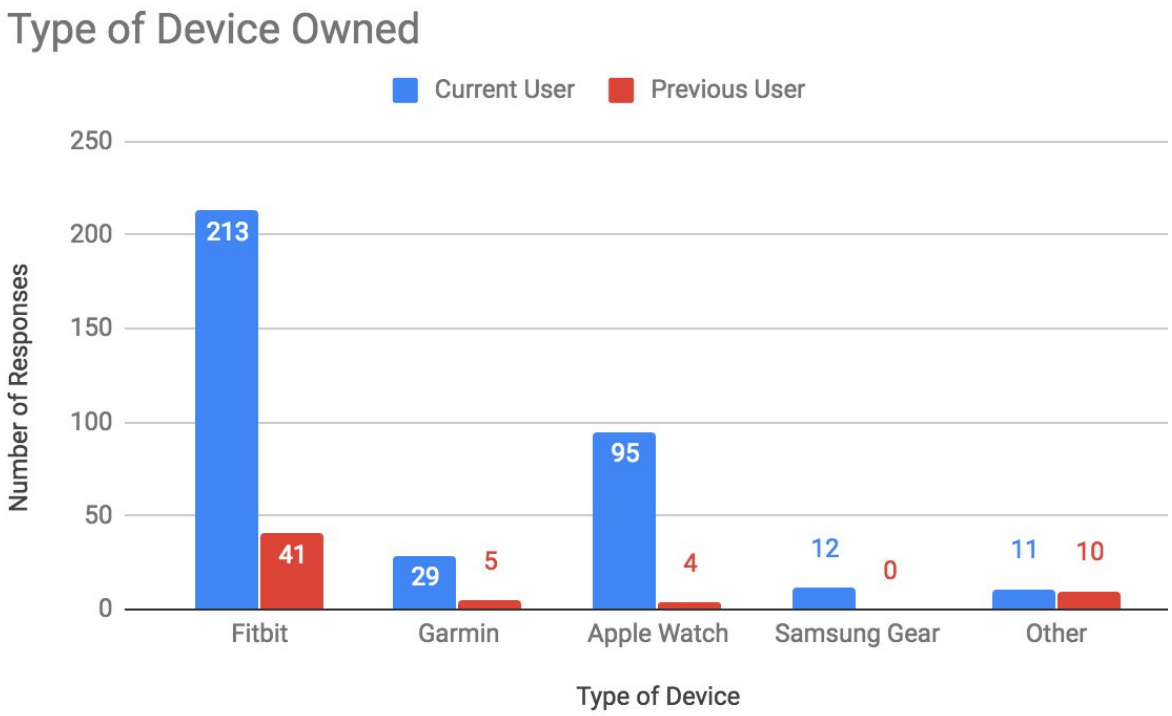

Figure 4. Comparison of type of device owned between current and previous users

A total of 100 current users reported they have owned a device for more than two years, while 98 users reported they have currently owned a device for one to two years. This was followed by 74, who reported six months to one year, 47 reported three to six months, and 41 reported owning the device for three months. In comparison, previous users' most popular responses were in the following order: one to two years (n=21), six months to one year (n=12), three months (n=10), three to six months (n=9), and more than two years (n=8) (Figure 5).

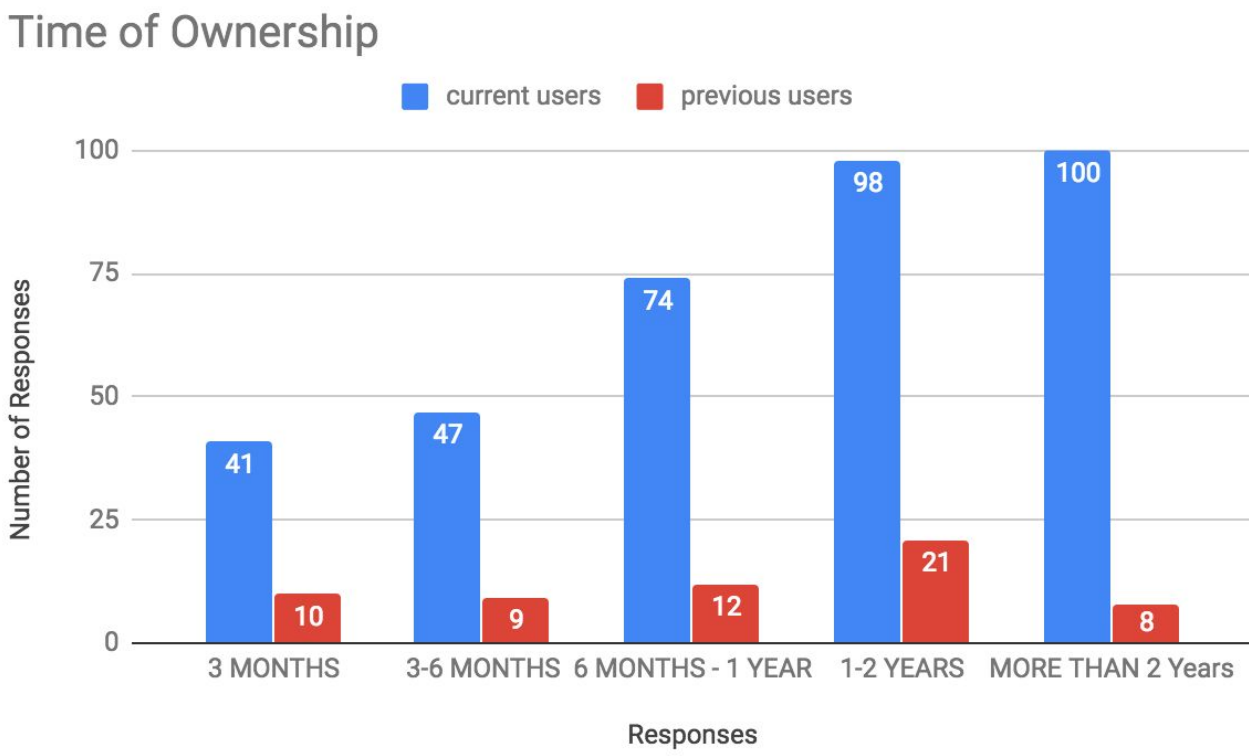

Figure 5. Comparison of time of ownership between current and previous users

Users also indicated their motivation for looking into or purchasing a device. They could select all responses that were applicable. The most notable response was n=190 current users indicated they wanted to improve their physical health. The most popular responses following improving their physical health are as follows: other (n=139), I wanted to change my habits (n=117), recommended by a friend (n=84), and recommended by a physician (n=1). Previous users followed a similar pattern as follows: I wanted to improve my physical health (n=21), other (n=18), recommended by a friend (n=16), I wanted to change my habits (n=5). No previous users indicated the device was recommended by a physician (Figure 6).

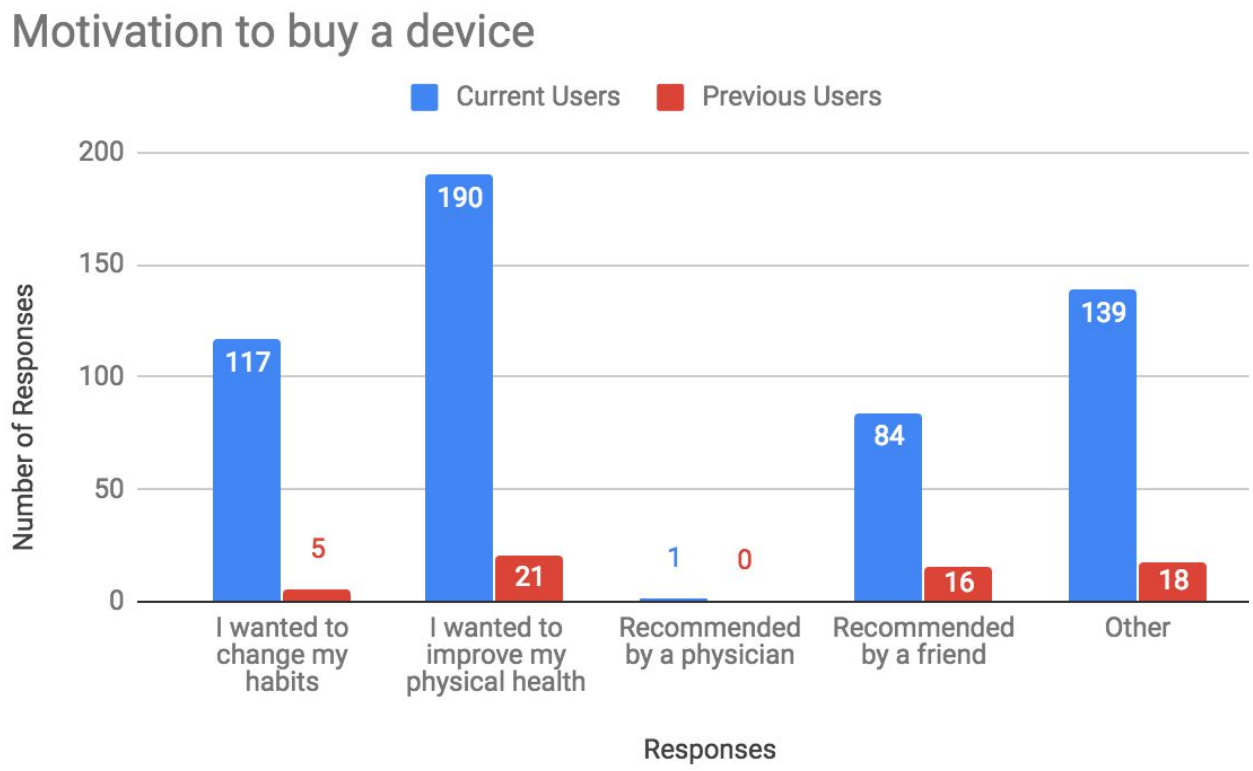

Figure 6. Comparison of motivation that caused users to look into buying a device between current and previous users.

A total of 157 current users indicated their reason for purchasing the device was because it tracked an activity they already did or liked doing, while 154 reported that they like the app the device is paired with. This was followed by 128 reporting price, 120 reporting that their family and friends used the same brand, 98 recommended by friends, and 80 reported other as reasons for purchasing their device. The most common responses for "other" were receiving the device as a gift or as a work incentive. Similarly, most previous users (n=23) also reported their reason for purchasing the device was because it tracked an activity they liked to do.

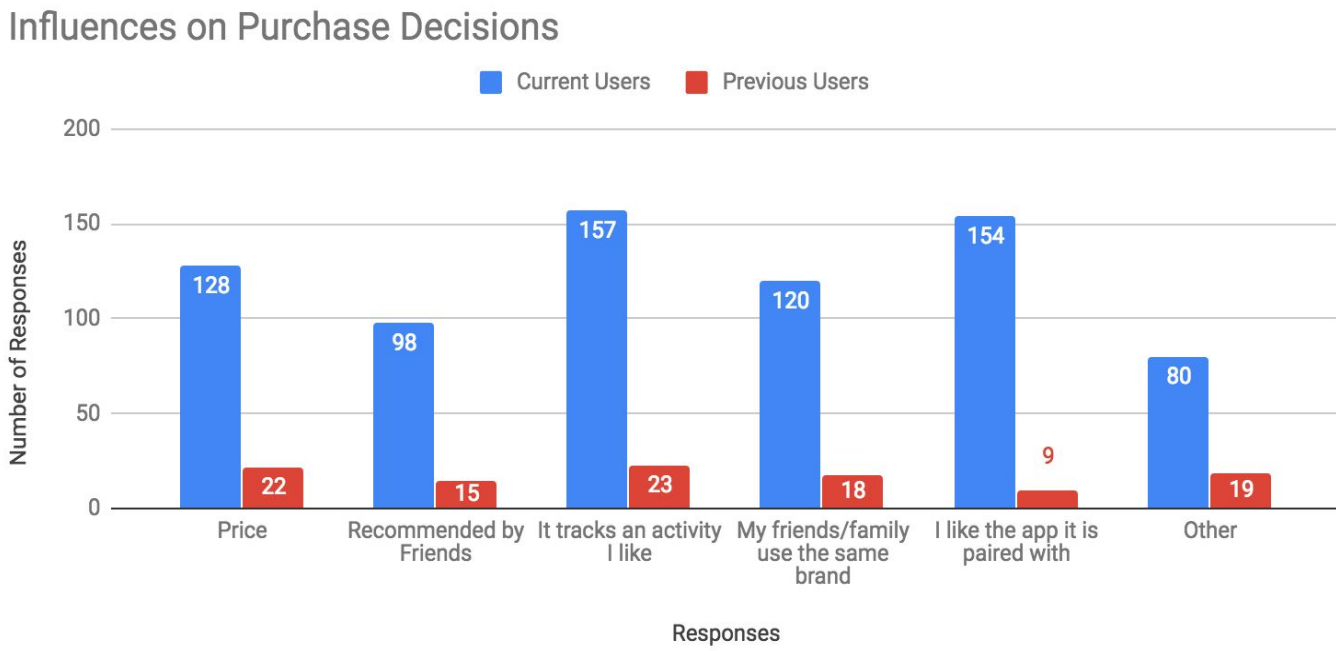

Figure 7. Comparison of factors that influence purchasing decisions between current and previous users

Survey participants also indicated which features were the most helpful on their devices. Participants selected all options that applied to them. Of the current users, 301 responses indicated that seeing their steps is the most helpful feature. This was followed by heart rate (n=210), notifications (n=204), it tracks specific exercises (n=167), it sets goals for me (n=163), and other (n=62). Several survey participants indicated that goals were important to them. For example, participant 122 stated, "I am very motivated to meet my goals everyday. I feel like I have let myself down if I don't meet my goals." Previous users followed a similar pattern: seeing my steps (n=54), heart rate (n=20), it sets goals for me (n=19), notifications (n=13), other (n=12), and tracking specific exercises (n=10) (Figure 8).

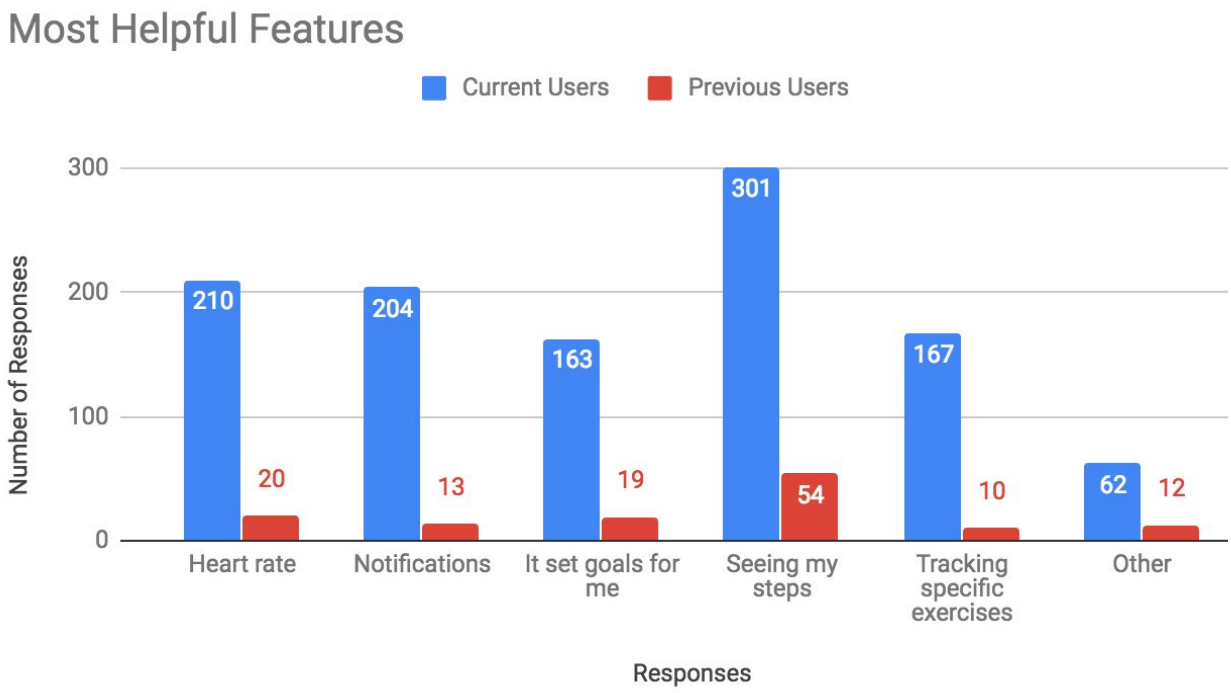

Figure 8. Comparison of which features are perceived to be the most helpful between current and previous users

The survey also collected data specific to current or previous users that was not compared. Nearly all of the current users, (n=324) indicated that the device motivates them to be physically active. However, only (n=312) indicated that they felt more motivated by the device. Most users have not owned a different device, but 122 users indicated they have owned more than one fitness tracking device. Nearly all users (n=340) plan to continue using the device they currently own (Figure 9).

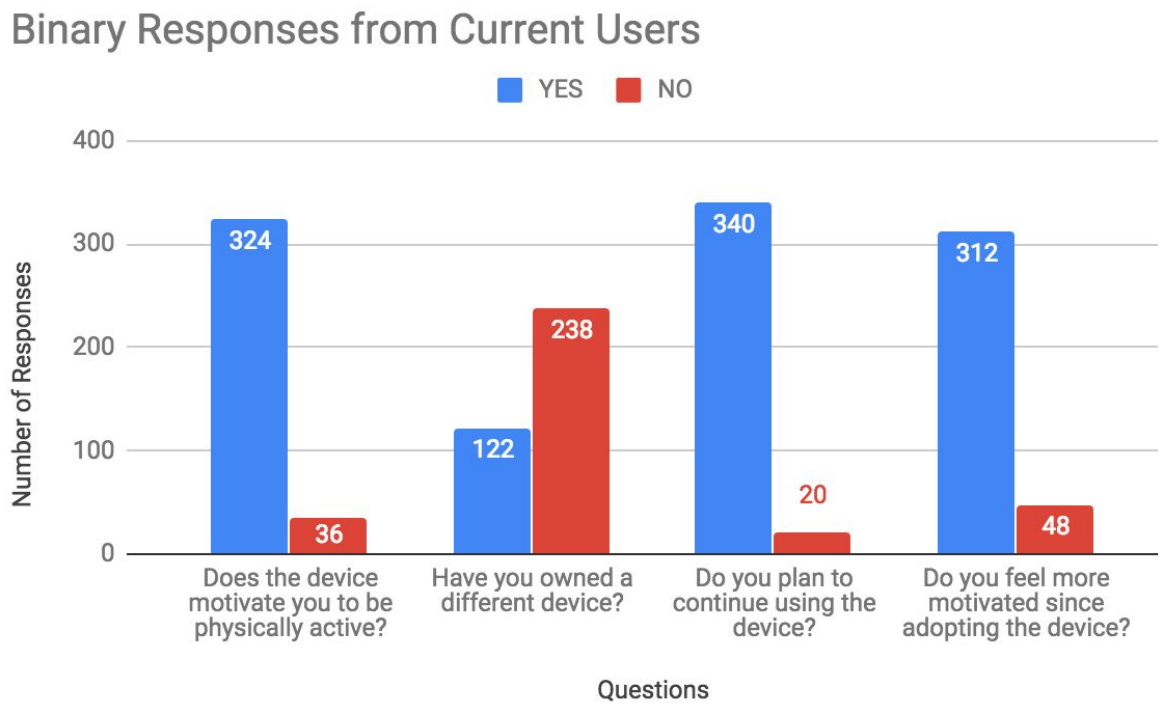

Figure 9. All binary responses from current users survey questions

A total of 122 participants indicated they owned a different fitness tracker (Figure 9). Of those participants, about half (n=65), indicated they had originally owned a Fitbit. The second most popular response was that users had upgraded from a previous Fitbit (n=17). Other big name brands that were previously owned by current users were Garmin (n=16), Samsung Gear (n=8), Apple Watch (n=5) (Figure 10). Participant 262 stated, “It wasn’t worth the investment to purchase a new device;” and participant 400 stated, “My Fitbit broke multiple times, so I upgraded to an Apple Watch that had more and was more durable.”

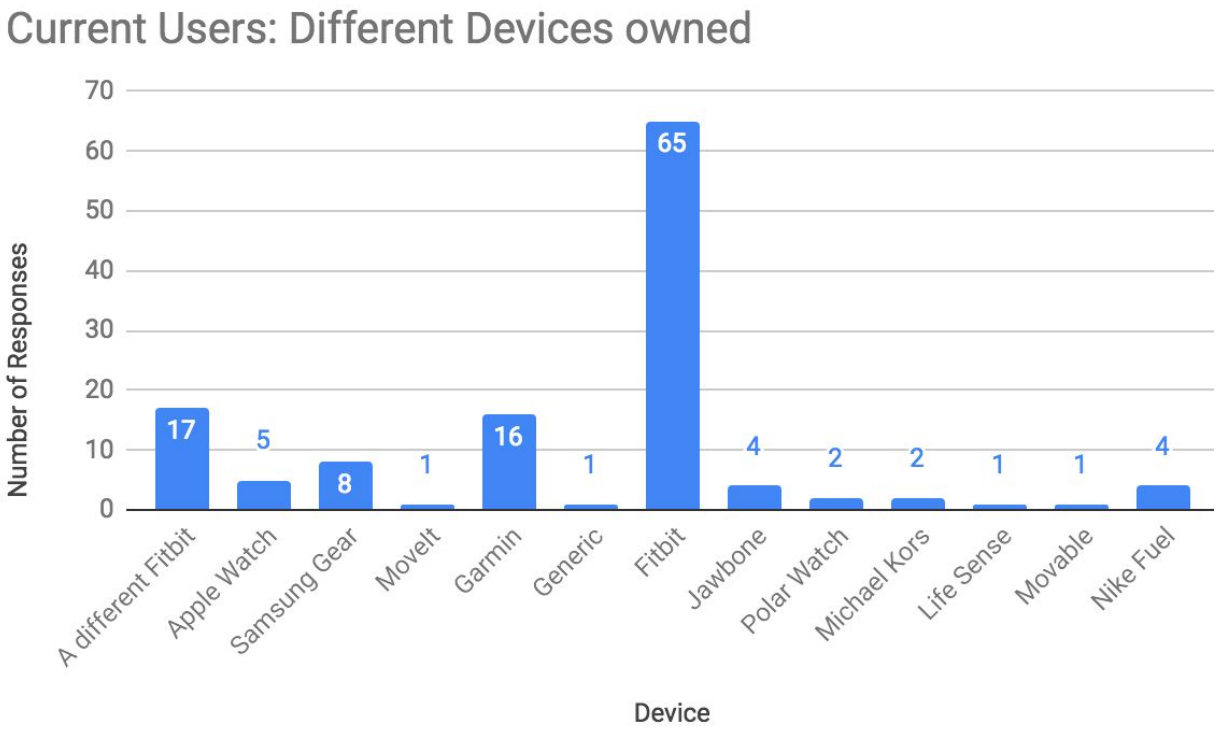

Figure 10. The different types of devices owned by current users

Most previous users (n=52) indicated that their device motivated them to be more physically active. They also indicated that the majority of these users did not attempt to try different devices before abandoning their devices (n=50) (Figure 11).

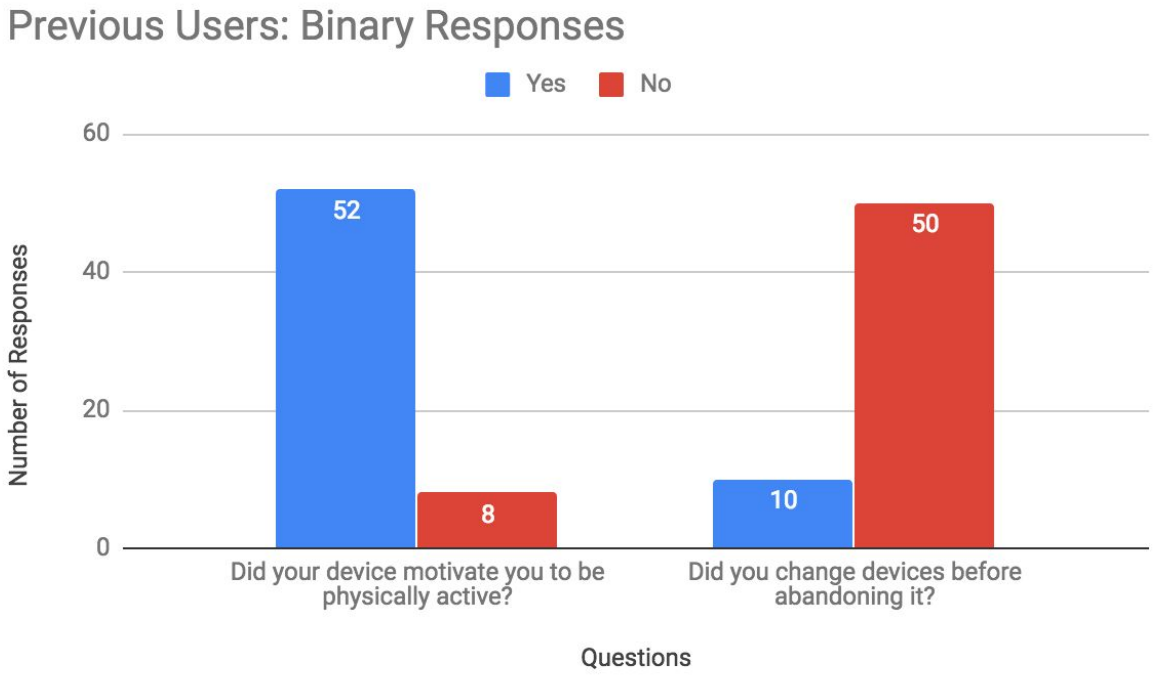

Figure 11. Binary response answers from previous users

Previous users indicated why they abandoned using the device. The most popular response was other (n=32). Responses marked as other were elaborated on as an open-ended question. The second most popular response was that users forgot about their device (n=16). The rest of the responses for device abandonment are as follows: device maintenance was too much work (n=9), it was uncomfortable (n=8), it did not appear to help me (n=7), it was difficult to use (n=1), and I didn't understand the feedback/data (n=1). Device maintenance includes items like charging the device and cleaning the device (Figure 12).

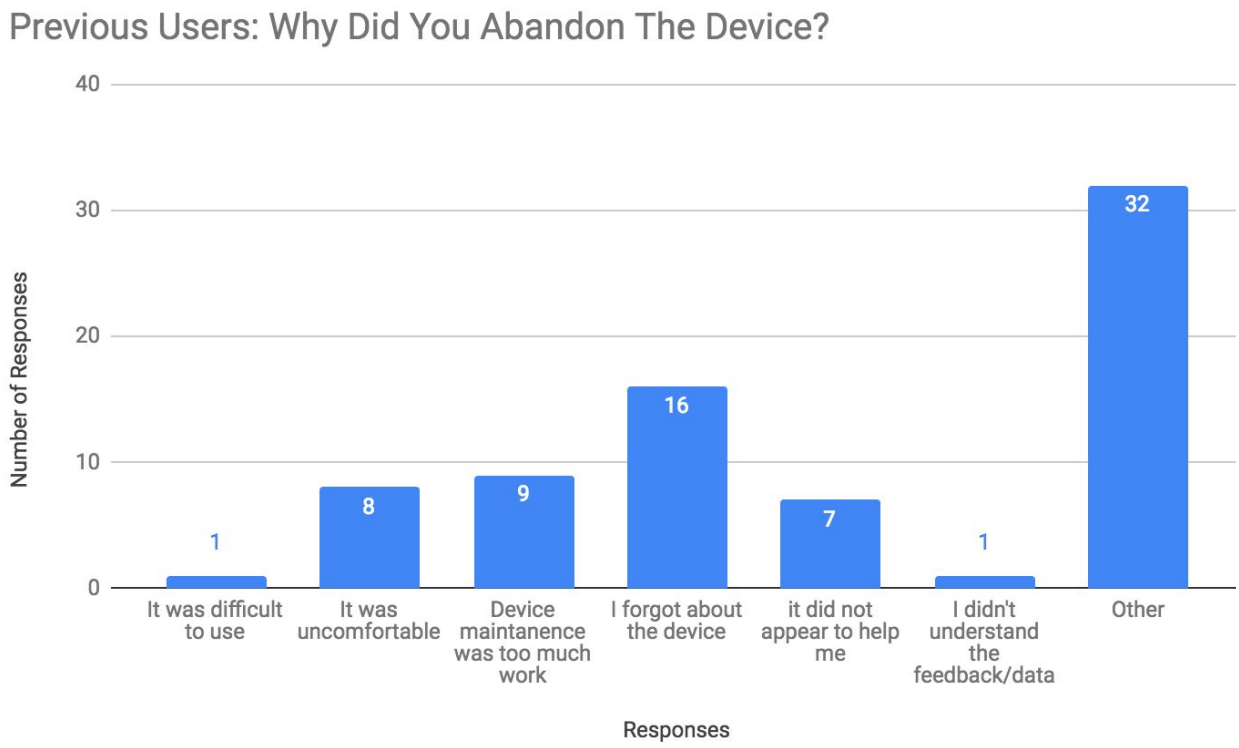

Figure 12. Previous users responses for why they abandoned using their device.

Statistical Analysis of Survey Data

The survey also included 10 Likert-scale questions. The Likert-scale ratings were 1-5 with 1 being strongly agree and 5 being strongly disagree. Questions from the Likert scale were compared against the type of device used and how frequently users worked out for statistical significance. One-way Anova was used to determine statistical significance between groups.

Type of Device

There was a statistically significant difference between the type of devices used as determined by one-way ANOVA ($F(4,414) = 5.222$, $p = .000$). A Tukey post hoc test revealed that participants' rating of the device's positive influence on their workout habits was statistically significantly higher for Samsung Gear users (2.75 ± 1.14 min, p = .021) and users of other devices (2.50 ± 1.10 min, p = .040) compared to Fitbit users (1.99 ± .8 min). There was no

statistically significant difference between the Fitbit and Garmin groups (p = .572) or between the Fitbit and Apple groups (p = .052).

There was a statistically significant difference between type of devices used as determined by one-way ANOVA (F(4,414) = 2.758, p = .028). A Tukey post hoc test revealed that participants' rating of the device's lack of influence on their workout habits was statistically significantly lower for Samsung Gear users (2.75 ± 1.71 min, p = .021) compared to Fitbit users (3.74 ± 1.04 min). There was no statistically significant difference between the Fitbit and Garmin groups (p = .565), between the Fitbit and Apple groups (p = .890) or between Fitbit and other groups (p = .993).

There was a statistically significant difference between type of devices used as determined by one-way ANOVA (F(4,413) = 3.418, p = .009). A Tukey post hoc test revealed that participants' rating of the device's encouragement to workout with friends was higher for other users (3.18 ± 1.71 min, p = .047) compared to Fitbit users (2.41 ± 1.20 min). There was no statistically significant difference between the Fitbit and Garmin groups (p = .943), between the Fitbit and Apple groups (p = .1.00), between the Fitbit and Samsung Gear groups (p = .095).

There was a statistically significant difference between type of devices used as determined by one-way ANOVA (F(4,413) = 3.043, p = .017). A Tukey post hoc test revealed that participants' rating of the device's easy usability was lower for Fitbit users (1.60 ± .79 min, p = .048) and Apple users (1.45 ± .72 min, p = .006) compared to other users (2.10 ± 1.15 min). There was no statistically significant difference between the other and Garmin groups (p = .076) or between the other and Samsung Gear groups (p = .828).

There was a statistically significant difference between type of devices used as determined by one-way ANOVA ($F(4,411) = 2.860$, $p = .023$). A Tukey post hoc test revealed that participants' rating of the device's usability prevented them from using the device to engage with physical activity was higher for Garmin users (4.38 ± .96 min, p = .032) and Apple users (4.26 ± 1.18 min, p = .033) compared to other users (3.50 ± 1.30 min). There was no statistically significant difference between the other and Fitbit groups ($p = .056$) or between the other and Samsung Gear groups (p = .053).

There was a statistically significant difference between type of devices used as determined by one-way ANOVA ($F(4,412) = 3.382$, $p = .012$). A Tukey post hoc test revealed that participants' rating of the device's maintenance not preventing them from using the device was lower for Fitbit users (1.75 ± .98 min, p = .046), Garmin users (1.56 ± 1.02 min, p = .027), Apple users (1.62 ± .94 min, p = .014), and Samsung Gear users (1.33 ± .65 min, p = .033) compared to other users (2.36 ± 1.40 min).

There was a statistically significant difference between type of devices used as determined by one-way ANOVA ($F(4,411) = 4.605$, $p = .001$). A Tukey post hoc test revealed that participants' rating of the device's maintenance preventing them from using the device was higher for Fitbit users (4.35 ± 1.02 min, p = .004), Garmin users (4.47 ± .99 min, p = .009), Apple users (4.48 ± .98 min, p = .001), and Samsung Gear users (4.83 ± .58 min, p = .004) compared to other users (3.55 ± 1.41 min).

Frequency of Exercise

There was a statistically significant difference between frequency of exercise groups as determined by one-way ANOVA ($F(3,411) = 3.173$, $p = .024$). A Tukey post hoc test revealed

that participants' rating of the device's positive influence on their workout habits was statistically significantly lower for participants who work out one to two days a week (2.03 ± .83 min, p = .029) and participants who work out three to five days a week (2.01 ± .92 min, p = .015) compared to participants who never work out (2.57 ± 1.07 min). There was no statistically significant difference between the participants who never work out and participants who work out more than five days a week groups (p = .160).

There was a statistically significant difference between frequency of exercise groups as determined by one-way ANOVA ($F(3,411) = 3.173$, p = .024). A Tukey post hoc test revealed that participants' rating of the device's positive influence on interacting with their friends for workouts was statistically significantly lower for participants who work out one to two days a week (2.32 ± 1.10 min, p = .037) compared to participants who work out more than five days a week (2.85 ± 1.51 min). There was no statistically significant difference between participants who work out more than five days and the participants who never work out (p = .390) or between participants who work out more than five days a week and participants who work out three to five days a week (p = .679).

Qualitative Survey Results

They survey included five open-ended response questions. Analysis of open-ended survey questions included the development of a coding schema designed to illuminate common themes and opinions about users' wrist-worn fitness tracker. Each unit of analysis was assigned a code to again represent a summative, salient, and/or essence-capturing attribute (Saldana, 2009). Statements that were irrelevant to this study — i.e., "I don't have a response," or "I don't know."

— were eliminated from the dataset. There were a total of 2,372 responses coded from the survey (Table 1).

Sixteen themes were identified from these results. Some themes had sub-categories that were frequently mentioned by participants. For example, within the theme of *positive statements about user experience*, participants frequently mentioned that they liked seeing their goals for the day on their device (n=239). This is a positive statement about the user experience but focuses specifically on one feature and is therefore a sub-category within the theme.

General statements included statements like "I really like the device," "it was hard to use," and "I don't like the design." *Statements about general habits* included statements like "I worked out before I bought my tracker." *Statements about social interactions* (n=45) included statements about how social interactions affected participants either positively or negatively. Statements about workplace incentives included statements such as, "work provides a discount for using this device," or "my place of employment stopped providing incentives so I no longer wear the device." *Positive statements about design* included statements such as "The device is small" and "the device is stylish."

There were several statements both positive (n=235) and negative (n=200) about usability. Several participants indicated that they wished their device was waterproof in open-ended questions (n=26). For example, participant 12 stated, "I wish my device was waterproof, I know newer versions are, but they are out of my price range." Additionally, the most common reason users abandoned their device was due to the device breaking or forgetting about the device (n=37). For example, Participant 395 stated, "The screen of my device broke so I was unable to access to use it because it was touchscreen. When it broke it changed the time so

I'm not able to wear it like a normal watch either." Participant 263 stated, "I simply forgot about it after not replacing the battery." A common statement among many participants was, "I forgot about the device." Another popular response for improvements to the device was accuracy (n=71). Participant 183 stated they would like, "more accuracy in steps, heart rate, amount and type of exercise, etc."

The most popularly discussed feature in free response survey questions was goals (n=239). Participant 263 stated, "I have always known the importance of exercise and have promoted regular exercise for all for many years. The motivation comes to do a little more each day when I have not met my goals for that day." Participant 288 stated, "My fitbit is a healthy reminder to be active in some regards everyday and it motivates me to reach my goals every day I can." Although goals are popular, they were also stated as something that made users feel guilty. Participant 251 stated, "There are lots of little reminders that I need to get my butt up and moving. It makes me want to 'close my rings' and I almost feel guilty when I do not."

Perception of data was also popular for participants to discuss in free response questions (n=72). Some users abandoned their device for this reason. For example Participant 151 stated, "Two reasons - 1) I was unhappy with the format of the data the app provided, and was not able to change the format it focused far too much on how many calories I had 'left' in the day, which I found to be unmotivating…" Participant 313 stated, "I became too reliant on how the data made me feel and the perceptions it gave me of myself."

Another popular statement in free-response questions were statements about gamification (n=69). Users found that they could make it a game to improve their data, or they could compete with friends to see who got the most steps during the week. Participant 187 stated, "I have

friends that I keep in contact with on my Apple Watch and we track/compete with each other." Participant 370 stated, "It sends reminders to be more active throughout the day and you can achieve badges after reaching so many goals and compete against your friends."

Feedback gathered from free-response survey questions	***Percentage Occurrence***	***Number of Statements***
Statement about general habits	**2.57**	**61**
Positive statement about social interactions	**1.90**	**45**
Statements about workplace incentives	**1.85**	**44**
Statement about receiving it as a gift	**1.73**	**41**
Statement about cost	**0.67**	**16**
Statement about brand loyalty	**0.50**	**12**
Statement about gamification	**2.91**	**69**
Positive statements about usability	**9.91**	**235**
general	0.46	11
efficient	0.51	12
compatible with other devices and applications	2.02	48
Device is automated and I don't have to initiate certain interactions	1.31	31
Use the device to set goals	1.58	36
I can call/text from my device	0.42	10
easy to use	1.73	41
The watch face is interactive	0.67	16
I can easily use it as a watch	0.76	18
I can use the device in the water (waterproof)	0.51	12
Negative statement about usability	**8.43**	**200**
general	0.71	17
The device is not efficient	0.80	19
The device is not simple enough	0.51	12
I can not call/text from the device	0.67	16
the device has poor battery life	2.19	52

The device is not compatible with other devices/applications	0.63	*15*
The syncing is unreliable	0.72	17
The auto-recognition does not consistently work	0.60	14
The device can't be used in water (not waterproof)	1.10	26
The device is not intuitive	0.51	12
Negative statement about device durability	**3.33**	**79**
general	1.98	47
wristband	0.46	11
The screen easily cracks	0.42	10
The battery dies and the device will no longer charge	0.46	11
Negative statement about device accuracy	**2.99**	**71**
Positive statement about experience	**50.13**	**1189**
General	2.07	49
The device is ubiquitous	2.91	69
I like that I can see my active minutes	1.31	31
I like that I can track my distance	0.84	20
I like the ability to track a variety of data	3.46	82
Calorie tracking	2.49	59
I like seeing my heart rate	2.61	62
I like seeing how well I sleep	1.90	45
I like seeing my steps	8.14	193
I like the move notifications	7.17	170
I like the goals	10.08	239
I like that I can track specific activities	1.31	31
I like feeling accomplished	0.63	15
I like the positive language	1.05	25
It becomes a part of my routine	0.55	13
I like the accountability	0.63	15
I like that I can see my progress over time	1.22	29
I like the achievements I get for meeting goals	0.93	22
I like that my data is measurable	0.84	20
Negative statement about experience	**10.33**	**245**

general	1.35	32
novelty of the device wears off	0.89	21
I would like it more if there were more features	2.23	53
I would like it more if it had a heart rate monitor	0.46	11
It makes me feel guilty or not confident	1.18	28
The device is uncomfortable to wear	1.05	25
Notifications are annoying	0.84	20
Device maintenance is inconvenient	0.76	18
The device is easy to forget about	1.56	37
Positive statement about design	**0.63**	**15**
Negative statement about design	**2.11**	**50**
It is not stylish or fashionable	0.67	16
It is bulky	0.89	21
It collects water, dust, etc	0.17	4
The screen or lack thereof	0.30	7
Total statements		**2,372**

Table 1. Free response analysis of open ended survey questions

Diary Results

The diary was coded similarly to the open-ended survey results. Coding results from the diary include the statements from participants diaries and exit interviews. There were 12 participants in the diary study. Participants were classified as active or inactive users of their Fitbits. Active users, on average, logged 150-200 or more words per day in their diary. Inactive users logged 150 or less words per day. There were five active and seven inactive participants. Statements that were irrelevant to this study — i.e., “I was sick today,” or “I spent most of the day in class” — were eliminated from the dataset. There were a total of 616 relevant statements analyzed (Table 2).

Eleven key themes themes emerged from the diary data. Some themes had subcategories within the themes. For example, the theme *negative statements about usability* had several subcategories such as *battery life*, and "Can't see past days on the app without daily syncing." The theme, *statements about functional interaction*, included statements such as "I learned how to use the device by watching YouTube videos," [P4] or "I played around with the device to learn how to use it" [P1].

The theme, *positive statements about accuracy*, included statements about the accuracy of the heart rate monitor, step counter, and calorie tracker (n=8). *Negative statements about accuracy* included statements about the same features being inaccurate (n=12). Participant 1 stated "I went deep sea fishing on vacation and the Fitbit recorded steps even though I did not move, so I don't think it's very accurate". "Negative statements about design" included statements about the overall look, size, and style of the tracker such as "I wish the design of the heart rate tracker was more flat because the design pushes into my wrist" [P7].

Statements about usability were split between positive (n=56) and negative (n=42). The most common positive statements were general statements (n=17), such as "the device is easy to use," [P6] and "The device is simple and I can easily remember how to do specific actions" [P4]. The most common negative statements were statements about battery life (n=18). Nearly all participants stated in their diaries at least once that they wished the battery would last longer, or that they would use certain features less because it drained the battery more quickly.

In general, participants enjoyed the experience of using the Fitbit Charge 2. There were often many statements about how cool or fun it was to use the device. For example, Participant 4 stated, "I love using the Fitbit and seeing all my health data. It's so cool." Many users also felt

that the Fitbit made them feel accomplished. Participant 5 stated, “Whenever I met my goals, it made me feel accomplished and good about myself.”

A concern among nearly all diary participants was accuracy (n=12). Participant 1 stated, “I went deep sea fishing today, and the device counted steps even though I clearly wasn’t walking.” Participant 9 stated, “The Fitbit was counting steps whenever I played the drums and seems to be inaccurate in step counts.” Another concern was how easily forgettable the device was (n=51). Nearly all participants had a period of one to two days in which they forgot to use the device. Participant 8 stated, “Once I put the Fitbit on the charger, it’s easy to forget about.” Participant 9 stated, “the frequent need to charge the Fitbit made it easy to forget to put the device on or wear it consistently.”

Another concern among participants was that the effects of the device tended to wear off towards the end of their six-week period (n=25). Active users felt more motivated, but inactive users felt that they were not more motivated in general. Participant 8 stated, “I found myself looking at it less and less the more I used it. My motivation when I received it was 4/10, it improved to a 6/10 several weeks after using it, but dropped back to a 4/10 during the last two weeks of the study.”

Feedback gathered from diaries and interviews	***Percentage Occurrence***	***Number of Statements***
Statements about functional interaction	**3.72**	**22**
Statements about general understanding	1.69	10
External Learning	0.51	3
Easy interactions	1.52	9
Positive statements about usability	**9.46**	**56**
General statements	2.87	17

Easy to learn	2.36	14
It is usable with my devices	1.69	10
It is usable as a watch	2.53	15
Negative statements about usability	**7.09**	**42**
Can’t see past days on the app without daily syncing	2.03	12
Battery life	2.36	14
Charge time	1.35	8
It can't be used around water (not waterproof)	1.35	8
Positive statement about accuracy	**1.35**	**8**
Negative statement about accuracy	**2.03**	**12**
Negative statement about design	**3.21**	**19**
Statements about features that motivate	**15.2**	**90**
General data collection	3.38	20
Monitoring my heart rate is motivating	1.69	10
Seeing my steps is motivating	0.84	5
Reaching the goals set is motivating	5.41	32
Seeing progress charts, weekly updates is motivating	1.86	11
Move reminder	2.03	12
Positive Statement about User Experience	**29.05**	**172**
General	7.09	42
It makes me feel accomplished	1.69	10
I like that it auto-recognizes what I am doing	1.18	7
Comfort	1.18	7
I like seeing high numbers on my step counts	3.04	18
I like the notifications	1.69	10
I like that I can see my sleep patterns	2.53	15
I like that it monitors my heart rate	2.53	15
I like that I can track my calories	2.36	14
I like that I can put numbers to what I'm doing	1.86	11
It becomes a part of my routine	2.7	16
I like that it helps me relax	1.18	7
Negative statements about user experience	**21.96**	**130**
General	1.01	6

The device is uncomfortable	2.53	15
Notifications can be annoying	0.84	5
The data makes me feel bad	2.7	16
It is time consuming to keep up with	2.03	12
The device is easy to forget about	8.61	51
Device novelty wears off	4.22	25
Results oriented statement	**1.86**	**11**
Statement about general habits	**5.07**	**30**
Total Statements		**592**

Table 2. Analysis of diary entries

Diary Exit Interviews

Exit interviews were transcribed and coded similarly to the open-ended survey results and the diary. Semi-structured interviews were conducted with the 12 participants that completed the diary study as per best practice indicated by Nielsen Norman Group. Five themes emerged from the interviews. Some themes contained multiple categories (Table 3).

The theme "negative statements about design," (n=6) included statements such as "I wish the design was flatter and smaller" [P8]. Additionally, Participant 10 stated that "I would like the design more if it looked more professional. I go to a lot of events that are business related and I would like a different material on the watch for those types of events."

In general, during interviews, participants expressed that the device was easy to use and learn. Participant 1 stated, "Once I played with the device some, I found it was easy to find what I was looking for and interact with." Participants 3, 4, 5, and 7 expressed interest in purchasing their own fitness tracking device at the end of the study.

Some participants indicated that they really enjoyed the tracking features of the devices (n=14). Participant 6 stated, "I can see how much I've done and compare it with how bad my

asthma has been that day." Participants 2 and 5 indicated that they enjoyed that they received weekly reports on their data and they could compare the current week to previous weeks. Some users also indicated that they wished steps were not the most important metric. Participant 2 stated, "I wish it didn't focus so much on steps, because I don't find steps to be an important metric."

Similar to the survey, interviewees also indicated that gamification motivated them to do better (n=4). Participant 5 stated, "It became a game to see if I could get more steps than the day before, or have a lower resting heart rate."

Feedback gathered from interviews	***Percentage Occurrence***	***Number of Statements***
Positive Statement about Experience	**38.66**	**46**
General statements	10.92	13
Statements about tracking sleep	2.52	3
It makes me feel accomplished	4.2	5
Statements about liking the exercise tracking features	11.76	14
The device is comfortable	4.2	5
Statements about wanting to buy their own fitness tracker	5.04	6
Negative statements about experience	**24.37**	**29**
General statements	2.52	3
The device is easy to forget about	4.2	5
The device is uncomfortable	5.04	6
The notifications can be annoying	3.36	4
The novelty of the device wears off over time	5.88	7
The device is uncomfortable to wear	3.36	4
Positive statements about usability	**19.33**	**23**
General statements	10.08	12
The device was easy to learn	5.04	6

Interactions were memorable	4.2	5
Negative statements about usability	**9.24**	**11**
Some interactions are unclear	3.36	4
Battery life is poor	5.88	7
Negative statements about design	**5.04**	**6**
Statements about gamification	**3.36**	**4**

Table 3. Analysis of exit interviews

The following chapter discusses the findings and identify key components that motivates users to adopt devices long-term, components that lead to device abandonment, and key requirements that exist to improve the user experience of fitness trackers.

Chapter 5: Discussion

This thesis chronicles the user experience of fitness trackers. It used a survey to compare the attitudes of current and previous fitness tracker owners, a six-week diary study to understand how users interact and create routines with their devices, and semi-structured interviews to understand how users felt about their experience with fitness trackers. This study worked to answer the following research questions: **RQ1:** What user experience factors contribute to increased motivation for users to be more physically active? **RQ2:** What specific aspects of the user experience drive users toward long-term adoption or abandonment of their devices? **RQ3:** What key requirements exist for fitness tracker designers and product developers to improve the user experience? This chapter presents five key components that increased user motivation to adopt a fitness tracker long-term, five themes that drove users to abandon their devices, and six key requirements to improve the experience.

User Motivation

The following factors were discovered to contribute to user motivation to adopt and continue to use fitness trackers: socialization, such as self-tracking, gamification, ease of use during and post physical activities, and information design. As hypothesized, social components, usability, and information design all proved to be important factors in motivating users. Unforeseen in the hypothesis was the importance of gamification in motivating users to adopt fitness trackers for long-term use.

Socialization

Social components, namely self-tracking, plays an important role in motivating users to adopt their device for long-term use. Designers and developers should continue to implement the

ability to share data between friends and family with the same brand of fitness trackers as well as continue to encourage reflection of data. Fitness tracking devices provide statistics on exercises, heart rate, and other biometric data. This data is then shared with a mobile application that is paired with the fitness tracking device. This collection of data is important to motivation because users can reflect on this data and users can share this data with friends to compare data. Self-tracking is reflective in that users can look at previous days, weeks, or months of biometric data. Storing this data allows for users to routinely track how they are doing. The concept of self-tracking is that users rely on this data to either improve or better understand themselves. By reflecting on this data, users can continue to improve themselves. This is one of the most effective ways fitness trackers motivate users. Sharing this data with the user allows users to better track and understand their health, as well as start a conversation about their health with others.

Users who have already established a workout routine or exercise frequently are more likely to engage in conversation about their biometric data with friends or family. Users who have already established a routine can compare their data or have a better understanding of how certain metrics affect their health. Sharing this data with others allows them to compare or engage in conversations with friends and family. Encouraging engagement with friends and family also allows for self-reflection in self-tracking because individuals can reflect on the comparison between one another and discuss how they might improve.

Additionally, users who own mainstream devices, Fitbit, Apple Watch, and Garmin, are more likely to engage with friends and family. These devices allow users to share data with others who own the same brand of device. For example, users that own a Fitbit can choose to

share the data on their profiles within the mobile app with friends users have added on the application. This allows for several things to happen. Users might exercise with their friends and then share that data and reflect together on how they can improve, or, users might engage in some friendly competition. Thus, through socializing with friends, users feel more strongly about the experience and continue to use the device as a means for reflection or socialization.

Gamification

Although it was not hypothesized that gamification would motivate users, this thesis discovered gamification motivates users to adopt their device for long-term use. Designers and developers should continue to implement gamification. Gamification works well with self-tracking because it encourages play while completing the monotonous daily routines of reflection or exercise. Fitness trackers should continue to include badges as well as language that encourages users to compete with themselves if they are unable to engage in challenges with their friends. If fitness trackers do not include this as part of the experience, designers and developers should consider including it in the experience as it encourages users to continue using the device long-term. There are three key ways fitness trackers can gamify their data rewarding badges, weekly competitions with friends, and encourage users to compete against themselves for better "scores." These techniques are helpful in adopting the device for long-term use because it makes what might seem to be a boring task and provides a way for users to engage with simple single or multiplayer gameplay.

Through being paired with its mobile application, the fitness tracker gamifies exercises or daily routines by rewarding users with badges. Badges are rewarded for a variety of reasons including setting new records, taking a certain amount of steps during a week, or reaching certain

goals. When users receive a badge, they are notified either via the fitness tracker or the mobile application when they sync their data. Badges can be received more than once, encouraging users to continue doing well and achieving certain goals set by the system or goals that users set for themselves.

Second, users are motivated by entering weekly competitions with friends or family members who own the same brand of device. Users create weekly challenges or competitions, and throughout the week they can compare their data with those they are competing with. For example, there are challenges to gauge which individual gets the most steps during the week. By competing with others to get the most steps or a higher "score," users are motivated to use the device and engage in more physical activity throughout the week.

Finally, fitness trackers motivate users by encouraging users to compete with themselves. In this manner, users are playing a single player game to improve their own "scores." Users can compare prior days' metrics and attempt to improve. Users can visually see this through the badges they earn, but also by comparing their own data. For example, users might feel compelled to compete with themselves by getting more steps in than they did the day before. In this way, they are trying to achieve a new high score.

Usability

Usability, or how easy it is to use the device during key scenarios, also plays a role in motivating users to adopt fitness trackers for long-term use. Designers and developers should consider how they can improve upon the ease of use of these devices. Ease of use is important both during and after users exercise. Many participants indicate that they do not look at their devices during a workout, but would like to. They do not look at the device because it is

inconvenient to easily find the data they need without affecting their exercise. For example, a runner who wants to check their pace might slow down while trying to view that data. Post workout users need to be able to access any data that might influence future workouts. Being able to easily locate their data allows them to better reflect on how well they did. Reflection is key to self-tracking. If it is not easy to find this data, either through the fitness tracker interface or the mobile application, users are less likely engage with self-reflection. Without this key engagement, users will likely not continue to use the device long-term.

During workouts, users engage with their fitness trackers to gauge how they are doing. The easier the device is to use during a workout, the more likely users are will choose continue using it. Ease of use during a workout is important because the fitness tracker should not distract from the workout, rather it should contribute to it. If it is hard to use the device users will not continue to use the device long-term.

Similarly, ease of use post workout is important to the user experience. Due to the reflective nature of a fitness tracker, users should be able to quickly access and see their data at the end of the day or end of an exercise they have tracked. Being able to easily interact with and see data such as heart rate, steps, or an exercise summary provides an opportunity for users to evaluate their day and understand how they can continue to improve. Once again, ease of use is important because if users are unable to easily use and access this information, they are unlikely to continue using the device.

Mainstream devices such as Fitbit, Apple Watch, and Garmin, are easier to use than lesser-known devices, as shown by statistical analysis. Users who engage with smaller companies or lesser known devices are more likely to abandon their tracker. Ease of use

contributes to a more enjoyable experience, specifically ease of use when viewing specific biometrics. Fitbit, Apple Watch, and Garmin have this data only a few clicks away, making it easier for users to engage with.

Information Design

Finally, information design also affects the user experience and encourages users to adopt a fitness tracker for long-term use. Designers should consider designing information so it is clear what metric is being displayed and that the metrics are up to date. Designers should also consider how quickly the information can be read. Additionally, how information is presented also affects the user experience. Due to the ubiquitous nature of the device, information should be presented as the user looks at it. The on-the-go nature of fitness trackers means users should be able to quickly see and understand the data that is being presented. Maintaining hierarchy in the design is key. Hierarchy allows users to see the most relevant information first, as well as allowing them to look at it quickly and not interrupt their activity or task. Furthermore, the way in which the information is presented affects how users perceive their data. It should visually encourage users to improve their routines or complete an exercise. Visual representations, such as the Apple Watch rings, shows users what they can still do and how close they are to accomplishing that particular task.

When information is clearly designed, users enjoy using their device more frequently. For example if users are monitoring their heart rate, they should be able to tell the information being presented is their current heart rate. The heart rate feature might also display average heart rate and resting heart rate. Again, the design of this information must be obvious so the user does not

confuse any of these numbers for the current heart rate. This also permits users to quickly look at the watch to see information and does not disrupt any activities they are doing.

Additionally, information should also be designed in a way that is visually encouraging for users, with representations such as graphs. For example, some devices have rings that fill up as the user meets their goals for the day. This is a visual representation of information that they can quickly view and feel motivated by. Visual representations of data make the fitness tracker more appealing to look at as well as allow users to quickly understand the data they are viewing.

Mainstream devices, such as Fitbit, Apple Watch, and Garmin, have strong information design. Users understand what data is being presented, and are able to use that data to their benefit. Understanding the data while being able to quickly view it is important to the user experience and long-term adoption. Users must understand that data to feel encouraged to continue using the device, if the information presented is unclear or takes too long to understand, users are less likely to continue using the device long-term.

Device Abandonment

The following factors were discovered to contribute to user motivation device abandonment fitness trackers, device appearance, maintenance, ease of use, device novelty, and device durability. Unforeseen in the hypothesis was the importance of device maintenance and durability.

Device appearance

Designers should consider how to improve the size of the device and make it smaller, while still maintaining the ability to present all relevant information. Additionally, they should also consider how to make the device more comfortable by considering button locations and

band sizes. Many respondents indicated that they believed the device could benefit from a smaller size. Users believe that fitness trackers are designed poorly due to their size and comfort. The larger design attracts more attention than users would like and they feel aware of how others perceive them due to its design. Furthermore, key interactive elements such as buttons may be placed poorly. The placement may enable users to unintentionally start tracking exercises by placing the buttons too close to the joint. Users may move their wrist, and begin an activity unintentionally. Designers should also consider how the bands are designed to improve how comfortable the wristbands are for users. Fitness trackers must be worn tightly to accurately track heart rate, however many users complained they could not find a balance between wearing it too tightly or too loosely. Designers should eliminate designs that cannot be easily adjusted without going up or down a size.

Many fitness trackers are designed similarly to watches. They are meant to be worn on the wrist, and look similar to a watch. This design is meant to help users feel more comfortable wearing their trackers on a daily basis. However, users believe fitness trackers are bulky. The bulky design encompasses the size and style of the watch face these devices have. A contributing factor to why users abandon their devices is that the watch face that users must interact with to see their data is too large and feels clunky. It does not appear to be sleek or stylish. Users become self-conscious of the appearance of their device and the experience becomes unpleasant.

Second, the design of the devices are uncomfortable to users. Fitness trackers are worn at nearly all times during the day and users may sleep with these trackers to track their sleep as well. However, users grow tired of the device if it is not comfortable. For example, buttons on the side of the device may sit on users wrists in an uncomfortable manner. Over time, the device

becomes too frustrating to wear and users abandon it. Another example is the heart rate monitor. The heart rate monitor must maintain close contact with the wrist to gauge users' heart rate. However, this requires the device be tight on the users wrist, which may also become uncomfortable and lead users to abandon their device. Additionally ,for users who wish to track their sleep may have trouble sleeping due to the comfort of the device.

Maintenance

Another factor that leads to device abandonment is device maintenance. Device maintenance is the time it takes for users to charge their devices and how the devices must be charged. Frequent charging leads users to give up on maintaining the device or to forget about the device all together. Designers and developers should consider an alternative charging option. Currently, devices are charged via a USB cable. Users find the process of remembering to charge this device to be tedious. Fitness trackers are not a priority for many users. Although they enjoy the experience and the feedback, they struggle to find a routine of charging their device in a way that they will not lose data. For example, most participants indicated they charged the device at night. However, this meant they lost their sleep data for that night. Designers and developers should consider how users can maintain the battery of their devices without taking the device off to charge to prevent the loss of data. Many users suggested they would implement wireless charging to improve their devices.

Many fitness trackers are rechargeable. Although some require batteries, this is infrequent. Rechargeable fitness trackers last on average about three days. More advanced trackers can last anywhere from one to two weeks. Many users find the charging process tedious

for their devices. However, if the device loses battery quickly, users become unhappy with the inconvenience of charging their device. They believe the charging process to be time consuming. Additionally, users struggle to remember to charge their device. As users become more acquainted with wearing their fitness tracker, they forget to check the battery life. They expect to be able to track their exercises, however, certain tracking systems, such as GPS will cause the battery life to drain more quickly. Depending on the frequency of exercise, trackers require more or less charging time. As users become more frustrating with the charging process, they also begin to forget to take the device off of the charger. Users may not actively choose to quit wearing their device due to the maintenance, but rather, they forget to continue using the device.

Usability

There are usability issues that also drive users to abandon using their devices. Devices that sync inconsistently or inefficiently, and perceived accuracy of data contribute to device abandonment. Developers should consider how they might improve the consistency of syncing as well as the efficiency of syncing. Devices should always work and work quickly. The design encourages on-the-go use, and when devices retrieve or send data slowly, users are not inclined to continue using the device if it is consistently slow. Additionally, developers should consider how to ensure the accuracy and consistency of fitness tracking devices. Inconsistency, inefficiency, and inaccuracy all lead to low trust in the device, thus leading to device abandonment.

First, devices sync their data to a mobile application they are paired with. Second, devices sync with GPS to track some activities. The first usability error is that devices do not always sync as expected. For example, users may attempt to sync their device and for unknown

reasons the device will not connect or it will connect and data will not sync to the mobile application. However, this may not always be the case. The device may also sync with no errors at all. As users experience more inconsistent syncing between the device and the mobile application, they can not engage in the reflection of self-tracking. If this happens frequently enough, users grow tired of troubleshooting, and thus abandon their devices. Additionally, devices may also sync slowly or inefficiently. When acquiring GPS signal the device may not always quickly acquire signal, or when syncing with the mobile application, sometimes it may sync in seconds, other times it will take minutes. If the device is working slowly, users become frustrated, even if they can see the system status. Again, this interrupts their reflection or self-tracking experience because it is perceived to be not working correctly or inefficient.

Second, devices are perceived to be inaccurate. Users rely on accurate data from their devices. Accurate data is key to a successful self-tracking experience if users are using their fitness tracking device to improve day-to-day. Perception of inaccurate data, or if the data is clearly inaccurate, causes users to lose trust in their device. Similarly to syncing, they begin to believe their device is not working properly. For example, a user might engage in an activity that their wrist moves frequently in, but they are not walking. Some devices count these activities as steps, although to the user this is clearly not a step. This prevents users from improving or gauging how well they are doing.

Novelty

Designers and developers should consider a variety of badges or options for interactive goal setting to encourage users to stay excited about the device. For example, similar to the rings on an Apple Watch, devices could have small celebrations when goals are met. With enough

variety, users may continue to be interested in meeting their goals long-term despite creating a routine. When users receive the same rewards or incentives over and over, those rewards lose their value. Designers and developers should consider how to prevent badges, rewards and challenges from losing their value. This could include allowing users to personalize how they view their goals. For example, survey respondents indicated they would enjoy being able to feed a virtual animal. Additionally, the novelty of a device wears off over time and users become less interested in the data the device provides as they develop a routine. This is due to the effects of reaching goals losing its impact and the device is easy to forget about. If users are able to begin meeting their goals daily by developing a routine, they are aware of when they do or do not meet it. They no longer need the device to provide this information. Additionally, users become used to wearing the device daily and forget about it. Designers and developers should consider ways the device can be impactful to users, even if they are successful in developing a new exercise routine.

Although reaching goals also motivates users, the impact of continuously reaching goals may wear off over time. Users who are able to meet their goals everyday may create a routine. The fitness tracker helps users to understand how their daily activities help to meet their daily goals. However, if there is little to no return for reaching these goals, or the reward is the same every day, users create a routine. By creating a routine, they no longer need the device to tell them how they are doing. The device serves as more of a reminder rather than encouragement or motivation.

Perhaps the most notable idea of novelty wearing off is that users forget about their device. This is due to creation of routines, forgetting their device on the charger after taking it

off, or in general becoming oblivious to the devices intended use. By creating routines, users no longer need the ubiquitous feedback from the device and become less dependent on the data to track their exercises. After a period of time, users may forget about their devices all together if they feel they no longer need it. The most popular way users forget about their device is when they remove the device to charge it. Often times, users will forget about their device once they are no longer wearing it. Rather than put the device back on, they leave it behind. Lastly, users may begin to no longer care about their device. Upon first purchasing, users are excited about their devices. As they continue to use the device, the excitement wears off and users are no longer interested in what the device has to offer.

Durability

Finally, poor durability also leads users to abandon their devices. Designers and developers should consider the materials used for the device as well as how to improve battery life long-term. Devices are fragile in that screens break or crack, batteries give out, or wrist breads break. Fitness trackers should include screens so users can easily access and view their data within the fitness tracking interface. However, these screens may easily break or scratch during a workout. If the device is not durable users tend to believe it is no longer worth the investment. While solutions exist to fix device screens such as buying only the fitness tracking piece, paying to replace the battery, or buying new wristbands, users believe it will not solve the problem long-term.

Designers should consider how to create more durable screens without sacrificing a fashionable design. The screen is arguably the most important piece of the tracker as this is the main interface. When screens are cracked, it can become difficult to see the data. If it is a severe

crack, the data may not be visible at all. Screens are important to the experience as this is the main way users view and interact with exercise data. If this piece of the tracker breaks easily, users will discontinue using it. Additionally, after a period of time, the battery no longer holds charge or quits working all together. For obvious reasons, this also causes users to abandon their devices. Finally, the wrist bands wear out over time. Although replaceable bands are available for purchase, users are unhappy when the original band breaks. Users expect bands should be more durable as they are meant to be worn daily.

Key Requirements

This thesis discovered six key requirements all fitness trackers should have for a positive user experience. This thesis hypothesized a heart rate monitor, goal setting functionality, easy to learn and use, customizable and fashionable design. The research supports these findings while also finding that accurate step counting and notifications are also key requirements for the fitness tracking experience.

HR Monitor

Designers and developers should consider including a heart rate monitor on all fitness trackers, how comfortable the design of the heart rate monitor is for users, and implementing smaller screens for these devices so users can access their heart rate data without opening the mobile application. Due to the over-saturated market, users assume all fitness trackers include a heart rate monitor. Those who did not have a heart rate monitor on their device wished their device included this feature. However, participants were concerned about the comfort of their devices, and many attributed this to the design of the heart rate monitor. The design may sit uncomfortably on an individual's wrist, or press too deeply into their skin. When creating new

devices with heart rate monitors, designers should address how this can be made smaller or more flat, while still giving an accurate reading of an individual's heart rate.

Through this research, it was discovered that there are a range of fitness trackers. Most fitness trackers include the same features, which includes a heart rate monitor. However, more basic fitness trackers do not include a heart rate monitor. Users who did not have heart rate monitors were disappointed that this was not available. Though it does not lead to users abandoning their device, it is a less pleasant user experience for those who want to gauge their cardiovascular health.

Finally, the heart rate should be quickly accessible at all times. Most trackers include a screen in which users can view their data. However, some more affordable devices do not include screens. Additionally, the heart rate should be one of the first screens users can navigate to as is it more important to users than other data.

Accurate Step Tracking

Designers and developers should consider how to improve the accuracy of step tracking as well as ensure that the data is quickly accessible at all times. While all devices should have a step tracking feature, designers and developers should ensure that these devices are as accurate as possible. Accurate tracking is key in gaining users trust early on when they first adopt the device. If users do not trust their device, they are more likely to abandon it or have a negative experience with it. Many users indicated in the survey that they would either improve the accuracy, upgraded to a new device they perceived would be more accurate, or abandoned the device. Additionally, step tracking is important to users as this is commonly how they measure how active they have been throughout the day. Similar to the heart rate, step data should be

quickly accessible at all times. This includes being able to access step data via the fitness tracker interface and the mobile application. When designing a fitness tracker, designers should consider how users will see and interact with their step data quickly via the fitness tracking interface. Respondents also indicated that if their device did not have a screen, it was frustrating to find data.

Every device counts steps differently. Some devices users can "cheat" by taking the device off and shaking it or swinging their arm without walking. For example, if users play instruments, such as the drums, the tracker should not count this activity as steps. Similar to the heart rate, step data should be quickly accessible at all times. All devices should have some type of screen that allows users to interact with this data at any point throughout the day without requiring a mobile phone. This allows them to quickly access to track where they are in terms of reaching goals or how to improve their workouts.

Reminders or Notifications

A feature that should be included in all fitness trackers are notifications or reminders for users to move or be active. Designers and developers should consider the voice that is portrayed through these notifications. While, "Move!" gets the point across, it also feels demanding. These notifications should be evaluated to ensure they are encouraging and motivating rather than demanding and demeaning. Additionally the language of notifications should be encouraging. While users enjoy these notifications, based on the language users may feel as though the device is judging them. Additionally, designers and developers should consider the ability to personalize the timeliness of notifications. Many participants indicated that notifications, while nice, could also become annoying based on how often they are received. Rather than only providing options

to turn these notifications on or off, designers should include options for how frequently users get these notifications.

Reminders and notifications help users if they have been sedentary for extended periods of time. Move notifications remind users to move, even if they are unable to exercise. Most fitness trackers have this feature, however, some do not. Additionally, users should be able to control how often these notifications occur. Based on different scenarios, users may be unable to move when the fitness tracker suggests moving. For example, users may be unable to do so if they are in class or at work. Notifications may not be timely and can be annoying. However, if the default timing of notifications is infrequent and users have control over setting these notifications, this is an effective feature.

Goals

Finally, designers and developers should consider ways to make goals more positive, encourage play, and include visual representations of user goals on all fitness tracking devices. Goals can pertain to steps, calories, or other specific exercises. Users feel motivated to exercise when they have goals to achieve. More than half of the participants indicated that the use of goals on their fitness tracker encouraged them, made them feel accomplished or made them have a more pleasant experience. By implementing goals, users feel they have something they can achieve or will feel more accomplished. Gamification can also motivate users to meet their goals as a source of motivation. Gamification can be implemented by designers as a way to reward users with badges for meeting or exceeding their daily goals. Additionally designers should consider how the fitness tracker visually shows rewards users receive. Also important is that there are a variety of rewards and badges available. As users constantly receive the same badges,

they develop a routine, but become less interested in the device. Furthermore, by implementing visualizations of how close users are to reaching their goals, they can easily monitor their progress throughout the day. Many survey participants indicated seeing a visual representation of their goals was a fun way to challenge themselves.

Positive language should include phrases such as, “good work!,” or “way to go!” For example, Garmin uses a “beat yesterday” campaign. When a user sets a new record or walks farther than they did before, Garmin celebrates by congratulating users. The screen informs users they “set a new personal best,” or that they “beat yesterday.” This language is more encouraging for users to continue meeting their goals or to do better than the goals they set for themselves.

Second, gamification of goals encourages users. Rewarding users with badges when they meet or exceed their goals makes them feel good about themselves. Gamification also motivates users to continue using their devices long-term. When users exceed their goals or “beat their scores,” the fitness tracker should visually show this with users. Gamification makes users more excited about meeting their goals, the device, and completing monotonous tasks.

Finally, devices should visually display how close users are to meeting their goal and when they have met their goal. For example, Apple Watch does this with rings. As users meet their goals, the rings close to make a full circle. Fitbit has a celebration of fireworks when users meet their goals. There should be some type of visual representation that both shows and celebrates in a visually engaging way when users meet their goals.

Ease of Use

Ease of use is a major key requirement for fitness trackers. The ubiquitous nature of these devices means users are interacting with them daily and in varying situations. Designers and

developers should consider how devices can be consistent and efficient. To do this designers and developers should address connectivity speed, how to quickly find all available features, and syncing should not be required daily. Connectivity speed is important for fitness trackers to display data, connect with a mobile phone, and acquire GPS signal. This is important because participants indicated that they became frustrated if the device worked slowly. If it consistently works slowly, users will believe the device no longer works and again lose trust in their device. Additionally, designers and developers should consider how users can quickly navigate to different features of the device. More advanced trackers have features that can sometimes take users months to discover. Users should be able to quickly and easily find these features upon exploring the device and remember how to locate specific features. Finally, developers should consider how to make syncing between the fitness tracker and the mobile application more efficient. Slow syncing was a top complaint of survey participants. Additionally, users were not always sure when the device was still syncing as there was not a clear indicator of the system status.

Fitness trackers display instantaneous data to users. This requires that fitness trackers work quickly to display the data users are viewing. For example, if users are viewing their step count for the day so far, they should be able to navigate to and immediately see their steps. There should be no delay in providing this data on the watch. Similarly, users should be able to quickly sync data to their mobile devices. When devices are inconsistent in their speed, users will believe it no longer works. If data is not available when users navigate to it on their device, users will lose trust that the device is working as it should.

Fitness trackers offer several different types of tracking features. Sometimes it is less obvious how users can track specific exercise activities, such as weightlifting. It should be clear to users how to find all tracking features, as this is the main use of fitness trackers. Many users are able to remember the interactions of their devices once they locate the features they need, but if they are unable to find them quickly, the experience becomes more frustrating than motivating.

Finally, syncing the data from the fitness tracking device to its paired mobile application is a critical part of the experience. Users interpret their data from the mobile application in order to reflect on their weekly progress. However, some devices require the fitness tracker to be synced daily. However, users often forget to sync their devices at this frequency. The fitness tracker should be capable of storing, at minimum, 2-3 days worth of data before removing it. This allows users to sync their device when it is convenient for them. If users forget, this allows for error prevention as well.

Customizable & Fashionable Design

Finally, it is a key requirement that the design of the fitness tracker be customizable and fashionable. Designers should consider how users can customize their devices in a cost effective manner, as well as consider current fashion trends. Currently, options exist to customize the style of the fitness tracker band. However, users believe these options are either not good enough or not cost effective. Additionally, users would like to be able to have more customizable options available for the fitness tracker. As previously mentioned, these are designed similarly to watches. However, users often times do not like the design or style of the "watch face." Allowing more options for users to choose what the watch looks like will reduce the possibility of users feeling self-conscious about wearing the device. Furthermore, the default design of the

watch band is silicone material. Users dislike this design because it does not appear to be fashionable. Leather bands or other options are available for additional purchase but users believe this is not cost effective. Designers should consider having more fashionable selections as the default rather than the standard silicone bands. Finally, designers and developers should consider how they might improve the experience of investing in a device so users are more encouraged to invest in more fashionable accessories or options.

Conclusion

Mainstream devices such as Fitbit, Garmin and Apple Watch are consistently used more often long-term by users. They help motivate users to adopt routines, as well as encourage users to upgrade or replace devices as they wear out over time. These devices should serve as inspiration for designers and developers when creating new devices on the market. Additionally, designers and developers should consider how to make devices more consistent in the features that are offered. Designers and developers can differentiate their devices from other by implementing different types of badges, graphic representations of goals, and the style of their fitness trackers.

The user experience is overall more appealing to users who are already motivated or have already developed a routine. The creation of a routine is not highly influenced by the device. Rather, the device serves as encouragement to develop a routine but does not effectively influence the creation of a routine if there is no prior motivation. However, Fitbit and Apple are more effective at encouraging users to not give up on their goal of creating a routine. Furthermore, fitness trackers that focus more on being an extension of a phone, such as Samsung Gear, are the least motivational in their user experience.

Finally, overall, the user experience is overwhelmingly positive for users who are already motivated to create an exercise routine. However, the elements that drive to device abandonment create many frustrations for users who generally enjoy using their devices to self-track. Fitness tracking experiences should continue to be innovative and create exciting ways for users to be excited for their daily workout routines. The experience should dull the monotony of repetitive exercise routines and provide users with the data needed to accurately reflect and improve. This will encourage more long-term adoption and discourage novelty of the device wearing off over time.

Future Work

Future work could include the development of heuristics for fitness trackers. This thesis lays a foundation for understanding how the user experience motivates users to adopt fitness trackers long-term. Additionally, future work could do a comparative study on how different trackers are successful in developing routines for users.

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Appendix A

Q1 Do you currently actively use a wrist-worn fitness tracking device (such as Fitbit, Garmin, Apple Watch, Samsung Gear)?

- o Yes (1)
- o No (2)

Skip To: Q15 If Do you currently actively use a wrist-worn fitness tracking device (such as Fitbit, Garmin, Apple... = No

Q2 What type of fitness tracking device do you use?

- o Fitbit (1)
- o Garmin (2)
- o Apple Watch (3)
- o Samsung Gear (4)
- o Other (5)

Q3 How long have you used your fitness tracking device?

- o Less than 3 months (1)
- o 3-6 months (2)
- o 6 months - 1 year (3)
- o 1 - 2 years (4)
- o More than 2 years (5)

Q4 What factors made you choose the device you currently use? (Select all that apply)

- ▢ Price (1)
- ▢ Recommendation from friends (2)
- ▢ It tracks a specific activity I do frequently (3)
- ▢ My friends/family use the same brand (4)
- ▢ I like the application it is paired with (5)

▢ Other, please explain: (6) _____

Q5 Does your device motivate you to be physically active?

o Yes (4)

o No (5)

Display This Question:

If Does your device motivate you to be physically active? = Yes

Q34 How does your device motivate you to be physically active?

_____

_____

_____

_____

_____

Display This Question:

If Does your device motivate you to be physically active? = No

Q35 Why does your device not motivate you to be physically active?

_____

_____

_____

_____

_____

Q6 If you think your device could be improved, what would you change about it?

_____

_____

_____

_____

_____

Q7 What features of the device do you find to be the most helpful? (Select all that apply)

- Heart Rate (1)
- Notifications (2)
- It sets goals for me (3)
- Viewing my steps (4)
- Tracking specific exercises (5)
- Other, please explain: (6) _____

Q8 What made you decide to purchase your fitness tracking device? (Please select all that apply)

- I wanted to change my habits (1)
- I wanted to improve my physical health (2)
- Recommended by a physician (3)
- Recommended by a friend (4)
- Other, please explain: (5) _____

Q9 Have you ever owned a different fitness tracker?

o Yes, which brand: (1) _____

o No (2)

Display This Question:

If Have you ever owned a different fitness tracker? = Yes, which brand:

Q12 If you changed devices, why did you change devices?

_____

_____

_____

_____

_____

Q10 Do you plan to continue using the device you currently own?

o Yes (1)

o No, please explain why not (2) _____

Q13 In general, would you say you feel more motivated to exercise since adopting the device?

o Yes (1)

o No (2)

Display This Question:

If In general, would you say you feel more motivated to exercise since adopting the device? = Yes

Q14 What functions of your device do you believe have helped motivate you to exercise?

_____

_____

_____

_____

_____

Skip To: End of Block If What functions of your device do you believe have helped motivate you to exercise? Is Displayed

Display This Question:

If In general, would you say you feel more motivated to exercise since adopting the device? = No

Q33 Why do you think your device didn't increase your motivation to exercise?

_____

_____

_____

_____

_____

Skip To: End of Block If Why do you think your device didn't increase your motivation to exercise? Is Displayed

Q15 Have you previously used a fitness tracking device?

o Yes (1)

o No (2)

Skip To: Q16 If Have you previously used a fitness tracking device? = Yes
Skip To: End of Survey If Have you previously used a fitness tracking device? = No

Q16 What type of fitness tracking device did you use?

o Fitbit (1)

o Garmin (2)

o Apple Watch (3)

o Samsung Gear (4)

o Other (5)

Q17 How long did you use your fitness tracker?

o Less than 3 months (1)

o 3 - 6 months (2)

o 6 months - 1 year (3)

o 1 - 2 years (4)

o More than 2 years (5)

Q18 What would you say led you to stop using the device? (select all that apply)

▢ It was difficult to use (1)

▢ It was uncomfortable to wear (2)

▢ Device maintenance was too much work (3)

▢ I forgot about the device (4)

▢ It did not appear to help me (5)

- I didn't understand the feedback it gave me (6)
- Other, please explain: (7)

Q19 Which were the most influential features that caused you to choose the device you purchased? (select all that apply)

- Price (1)
- Recommendation from friends (2)
- It tracked a specific activity that I did (3)
- My friends/family used the same brand (4)
- I liked the application it was paired with (5)
- Other, please explain: (6)

Q20 What features of the device did you find to be the most helpful? (please select all that apply)

- Heart rate (1)
- Notifications (2)
- It set goals for me (3)
- Seeing my steps in a day (4)
- Tracking bike rides (5)
- Tracking specific exercises (6)
- Other, please explain: (7)

Q38 Why did you choose to stop using your device?

_____
_____
_____
_____
_____

Q21 In what ways do you think the device be improved to adopt it for long term use?

_____
_____
_____
_____
_____

Q22 Did you device motivate you to be physically active? In what ways did your fitness tracking device motivate your desire to be physically active? If it didn't motivate you why not?

o Yes (4)

o No (5)

Display This Question:

If Did you device motivate you to be physically active? In what ways did your fitness tracking devic... = Yes

Q36 How did your device motivate you to be physically active?

_____
_____
_____
_____
_____

Display This Question:

If Did you device motivate you to be physically active? In what ways did your fitness tracking devic... = No

Q37 Why do you believe your device did not help motivate you to be physically active?

_____
_____
_____
_____
_____

Q23 What made you decide to purchase your fitness tracking device?

o I wanted to change my habits (1)

o I wanted to improve my physical health (2)

o Recommended by a physician (3)

o Recommended by family/friends (4)

o Other, please explain: (5) _____

Q24 Did you ever change devices before abandoning it?

o Yes (1)

o No (2)

Display This Question:

If Did you ever change devices before abandoning it? = Yes

Q25 How did changing devices impact your workout routine?

_____

_____

_____

_____

_____

Display This Question:

If Did you ever change devices before abandoning it? = No

Q26 Why did you not change devices?

_____

_____

_____

_____

_____

Q27 Below is a list of statements about using a fitness tracker. Please indicate how strongly you disagree or agree with each statement.

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
The device helped me change my habits involving physical activity. (1)	o	o	o	o	o
The device I use/previously used has not created any new habits involving physical activity. (2)	o	o	o	o	o
Participating with my friends/family that use the same brand of device encourages me to be more active. (3)	o	o	o	o	o

Participating with my friends/family that use the same brand of device has not helped improve my self perception of improving physical activity. (4)	o	o	o	o	o
Awareness of what is beneficial to my health encourages me to use the device. (5)	o	o	o	o	o
Social pressures – such as judgment on weight, strength and ability – discouraged me from using my device. (6)	o	o	o	o	o
The device was easily usable and well designed. (7)	o	o	o	o	o

The design and usability of the device prevented me from using it to its full potential. (8)	o	o	o	o	o
Device maintenance was not difficult and did not discourage me from using my device. (9)	o	o	o	o	o
Device maintenance required more effort than I expected and discouraged me from using my device. (10)	o	o	o	o	o

Q28 What is your age?

- o 18-24 (1)
- o 25-34 (2)
- o 35-44 (3)
- o 45-54 (4)
- o 55-64 (5)
- o 65+ (6)

Q29 Gender identity

o Male (1)

o Female (2)

o Non-binary/third gender (3)

Q31 Where are you from?

_____

Q32 How frequently do you exercise?

o Never (1)

o 1 - 2 days a week (2)

o 3 - 5 days a week (3)

o More than 5 days a week (4)

Q41 Please provide your e-mail if you are willing to participate in any follow up questions to your survey responses (this is voluntary)

_____