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A QUALITATIVE ANALYSIS OF THE UNINTENDED EFFECTS OF FOOD TRACKING  
APPLICATIONS

LAUREN DOUTT  
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Reviewed and approved\* by the following:

Steven Haynes  
Teaching Professor of Information Sciences and Technology  
Thesis Supervisor and Honors Adviser

Xiaolong Zhang  
Associate Professor of Information Sciences and Technology  
Faculty Reader

\* Signatures are on file in the Schreyer Honors College.

## ABSTRACT

Food tracking applications allow users to enter their food consumption into an app in order to keep track of their calories and view their nutritional breakdowns. Over the past few years, these applications have become more widely used. This exploratory study examines the unintended and maladaptive effects of food tracking applications on a user's eating habits. Twenty people were interviewed about their experiences using the applications. Qualitative analysis was conducted, and various themes emerged in the users' feedback. In order to understand unintended consequences, it is important to understand the intended goals users had when using the application. The five goals subjects had ranked from most popular to least popular were to improve self-awareness, lose weight, discover food intolerance, maintain weight, and gain muscle. Unintended and maladaptive effects subjects experienced ranked from most popular to least popular were they became aware of unhealthy food but still ate it, experienced unexpected guilt, experienced unhealthy eating, learned new information about their diet, and changed their eating habits based on data entry. Design implications suggested are changing colors that are used in the app, expanding the applications' food databases, changing the reminder settings in the app, keeping track of food intolerances, and promoting awareness of important pre-existing features.

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## Chapter 1

### Introduction

Today users that want to learn more about their body can use sensors to track their bodily functions and health habits (Lupton, 2013b). Wellness tracking applications also known as wellness tracking apps are becoming increasingly popular (Murnane, Huffaker, & Kossinets, 2015). These types of apps can track food, sleep, exercise, and menstrual cycles among other activities and characteristics (Lupton, 2013a). Specifically, significant research is being done on food tracking applications in order to better engage users and improve their experience (Luhanga, Hippocrate, Suwa, Arakawa, & Yasumoto, 2016a). Examples of food tracking apps that are available for Android and Apple phones include MyFitnessPal, LoseIt, Fitbit App, Map My Walk, and MyPlate. Since the recent rise in popularity of these applications, the way the applications affect people is an area open for study.

Before conducting my research, I emailed a registered dietitian inquiring about food tracking applications and her clients' experience with them. One question I had was, did the food tracker help them achieve their goals? Her response was,

*I would say yes for some and no for others. I'd say a majority would be no and that many people did not stick to tracking since it's not very easily sustainable (J. DeGore, personal communication, October 26, 2018).*

Another question I asked was, Did the clients experience any anxiety, guilt, or obsession with the app? She wrote back,

*Absolutely all of the above, which is why I discourage tracking. Often times clients would disregard hunger cues for fear of "going over" on calories or a macronutrient. Nutritional needs*

*vary day to day as do cravings, hunger, etc. which is why I feel this app is not a great idea for most clients (J. DeGore, personal communication, October 26, 2018).*

An additional question I asked was, do you think there are design improvements that could be made in these applications? If so, what are your suggestions?

She responded,

*I just don't think the amount of calories in a meal should be decided by an app. If someone is concerned about nutritional needs or balancing meals that is why we have actual health professionals that can help them. I think tracking is something that is very trendy now, but I don't think it is a super useful tool for most people to eat healthy (J. DeGore, personal communication, October 26, 2018).*

The correspondence with the dietitian confirmed my research question that these applications have room for improvement and users might have individualized experiences with the applications that might include unintended effects. The purpose of my study is to explore the unintended effects of food tracking applications on a user's eating habits. My central research question is: does caloric tracking in food tracking applications have unintended effects on a user's eating habits, and do these suggest design implications for such apps? By identifying undesired effects from using the applications, possible design changes can be discovered and can be used to improve the apps' design. Software developers can learn from my research when designing food tracking apps in the future.

## Chapter 2

### Literature Review

Areas of study that relate to my research question include the quantified self, wellness tracking applications, calorie tracking, effects of food tracking applications, and unexpected effects of food tracking applications. This section presents research that discusses why people track their bodies and how technology has enabled easier logging. Further research addresses how tracking has had effects on users' lives and how some of the effects may be undesired. This relates to my research question because the unexpected effects of food tracking applications on users' eating habits are still not fully explored.

### The Quantified Self

There has been a growth in the *quantified self* movement, where people use technology to track information about their body regularly, analyze this information, and store their data (Choe, Lee, Lee, Pratt, & Kientz, 2014; Lupton, 2013b). Users have several motivations for this tracking, experience different tracking phases, and collect the data through emerging technology (Choe et al., 2014; Li, Dey, & Forlizzi, 2011; Lupton, 2013b).

The motivations for participants in the quantified self movement are to improve their health and learn more about their bodies (Choe et al., 2014; Lee, 2014). One study analyzed online presentations given by quantified-self communities to better understand the members and what occurs at their meetings (Lee, 2014). The meetings were available for members to discuss their data collection. The participants noted statistical and scientific ideas to understand their data which include correlation, experimental design, and variability (Lee, 2014).

There is a discovery and maintenance phase of reflection for these self-trackers (Li et al., 2011). The discovery phase occurs when the users haven't identified their goals or the factors affecting their actions yet (Li et al., 2011). The maintenance phase occurs when the users want to maintain their current

body type (Li et al., 2011). According to one study, questions people had about their self-tracking were placed into the categories of history, status, context, factors, and discrepancies (Li et al., 2011). Users wanted to see their long-term data, current standing, and factors that might be affecting their information. Users also wanted to see how far they were from their goals (Li et al., 2011).

Research on users self-monitoring their activities and bodies began in 1970, but humans have been tracking themselves throughout history (Choe et al., 2014; Lupton, 2013b). Currently, sensors can be connected to smart devices to collect information about users' bodies and the data gives an overview of health habits and functions (Lupton, 2013b). Gyroscopes, accelerometers, and altimeters can measure movement and position (Lupton, 2013b). These self-trackers can collect data on diets, moods, heart rate, exercise, dreams, and much more (Lupton, 2013a). Self-monitoring has been built into applications in order to change users' behaviors (Choe et al., 2014). Sensors collect data while applications analyze the data with various algorithms (Schüll, 2016). Apps using this data can then provide advice to the user on what their future behavior should be (Schüll, 2016). The cost of devices has decreased, and device availability has increased allowing the quantified self movement to become more popular (Lee, 2014).

Since Kelly Kevin and Gary Wolf first made the quantified-self website in 2008, the movement has risen in members (Lupton, 2013b). These users are living through numbers, by taking data about their body and using the information to understand themselves (Schüll, 2016). The movement has become so popular that at the 2014 Consumer Electronics Show 300 companies targeted digital health products (Schüll, 2016).

### **Wellness Tracking Applications**

Use of wellness tracking apps have become a popular trend (Murnane et al., 2015). There are thousands of apps in the Apple app store that can display recommendations about health to users. In addition, research is being conducted on these apps in order to improve them (Luhanga et al., 2016a).

These efforts include gamifying food tracking, making data entry easier, incorporating machine learning, and utilizing motion detection (Graf, Krüger, Müller, Ruhland, & Zech, 2015; Luhanga, et al., 2016a; Rabbi, Pfammatter, Zhang, Spring, & Choudhury, 2015; Thomaz, Essa, & Abowd, 2015).

In the United States, 64% of adults have smartphones and about 19% own a wellness related app. (Murnane et al., 2015). Many users reported discovering these apps from friends or family (Murnane et al., 2015). Wellness tracking apps have become popular and aim to improve users' health awareness and motivation (Murnane et al., 2015).

Wellness apps can track food, menstrual cycles, exercise, sleep, etc. (Lupton, 2013a). Some popular examples of wellness apps are MyFitnessPal, LoseIt!, WebMD, GlucoMo, Sodium 101, MyNetDiary, iMapMyFitness, and Digifit (Millington, 2014). Even Instagram, a photo sharing social media platform, has been used as a fitness app when users post photos of food to track their meals (Chung et al., 2017). Users are then able to receive and offer social support while tracking their food (Chung et al., 2017).

Most wellness apps make recommendations based on entered physical information where numerical data is aggregated and displayed in graphs (Rabbi et al., 2015). For example, MyFitnessPal displays the user's results, food goals, and exercise goals in charts and graphs (Evans, 2017). MyFitnessPal along with other diet tracking apps have large databases for users to select their meals (Evans, 2017). Also, there are previous meals and lists of the user's favorite foods for quick entry (Evans, 2017).

Researchers are exploring various developments in food tracking apps to improve data entry and user interaction. Some researchers have attempted to gamify food tracking. One development called Happyinu tries to motivate users to develop a habit of food entry (Luhanga et al., 2016a). Virtual cash is used as an incentive for the users. The app also uses photo-based tracking (Luhanga et al., 2016a). It is set up as a "pet-care game" where the users need to upload their food pictures to take care of their pet (Luhanga et al., 2016a). Food4Thought is another app that has used gamification in its design (Epstein,

Cordeiro, Fogarty, Hsieh, & Munson, 2016). Food4Thought motivates users to participate in “crumbs” which are daily food challenges. Users eat a specific food a day in order to meet a challenge (Epstein et al., 2016). The app uses the daily challenge to guide users to complete small and diverse goals (Epstein et al., 2016).

Other developments aim to make data entry in food trackers easier since entering food can be tedious. One app “Nombot” is a chatbot that utilizes a messaging service called “Telegram” (Graf et al., 2015). Nombot chats with the user and analyzes their messages against food databases to record their meals (Graf et al., 2015). Other research shows photo-based food tracking has also been used to ease data entry (Cordeiro, Bales, Cherry, & Fogarty, 2015).

Some developers hope to change food tracking apps in more sophisticated ways by incorporating machine learning. One example is the MyBehavior app (Rabbi et al., 2015). MyBehavior is an app that tracks fitness, food and, location (Rabbi et al., 2015). It analyzes the users’ diet and workouts to examine what behavior is done frequently (Rabbi et al., 2015). Then, the app uses *multi-armed bandit* (MAB), a machine-learning algorithm. MAB makes recommendations to the users so they can to attain their goals (Rabbi et al., 2015). MAB can give suggestions on what behavior to change, stop, or follow in order to succeed in their diet (Rabbi et al., 2015).

Other research aims to understand users’ eating through motion detection. One study used a 3-axis accelerometer in a smart watch to identify moments when a user is eating (Thomaz et al., 2015). This type of detection could be used to detect moments when the user is eating food when it is not scheduled in their diet. An implication with motion detection is the sensor had instances of false positives, the sensor detected the user was eating when the user was just chatting on the phone, brushing their hair, or combing their hair (Thomaz et al., 2015).

Users of fitness apps reported they appreciate an easy to use interface, the convenience of the apps, and personalized characteristics within the apps (Tang, Abraham, Stamp, & Greaves, 2015). Two features users hope to see in fitness apps in the future are adaptive interfaces and motivational support

both based on context (Luhanga, Hippocrate, Suwa, Arakawa, & Yasumoto, 2016b). With additional research, all of these features could improve the way users engage with wellness apps. Overall, wellness apps have become a popular user initiative to maintain a healthy lifestyle and with new developments, tracking could become revolutionary.

### **Calorie Tracking**

Calorie tracking is a popular feature used in food tracking apps that can influence a user's food selection (Didžiokaitė, Saukko, & Greiffenhagen, 2018; Lim, Penrod, Ha, Bruce, & Bruce, 2018). As revealed by the quantified-self movement, through numbers people can gain self-knowledge about their bodies (Didžiokaitė et al., 2018). When observing the popular food trackers, one feature included on most apps is the caloric tracking feature, which counts the users' daily food consumption. Calorie tracking technologies can project nutrient percentages and total calorie intake (Simpson & Mazzeo, 2017).

One study interviewed users who used calorie counters within the app MyFitnessPal (Didžiokaitė et al., 2018). The study wanted to identify the users' goals, the app's effects, and the app's uses. Most of the participants used the app to lose weight, in order to improve their appearance. Some mentioned they wanted to improve their health habits (Didžiokaitė et al., 2018). Users reported using the apps for their basic features such as calorie tracking (Didžiokaitė et al., 2018).

Various factors in a users' food selection include healthiness, quality of taste, and convenience (Lim et al., 2018). When people put importance on long-term benefits from healthy food rather than momentary satisfaction from unhealthy food, they can make improved food choices (Lim et al., 2018). Calorie tracking raises awareness among users. One study had 178 subjects perform a food selection task (Lim et al., 2018). Some subjects were shown calorie information and others weren't. Those who were shown calorie information chose healthier foods and took longer to make their selections (Lim et al.,

2018). Although caloric tracking can influence user's food choices, it may have both healthy effects and unintended effects on a user's eating habits.

### **Effects of Food Tracking**

The companies developing food tracking apps advertise that they can achieve various fitness goals through using their apps (Millington, 2014). These advertisements generally match up with the users' intended goals and research shows these goals can be achieved (Didžiokaitė et al., 2018). The effectiveness of food tracking apps has been compared to other data entry methods (Wharton, Johnston, Cunningham, & Sterner, 2014). In addition, the self-management feature in these apps can be used for those with chronic conditions (Wilde & Garvin, 2007).

Developers of food trackers market the apps by projecting what users can achieve through using the apps (Millington, 2014). One study analyzed popular health tracking apps ranked in a Canadian Broadcasting Corporation report (Millington, 2014). The results show that the health apps all advertised improving oneself and achieving fitness goals. The advertisements also suggested apps can allow users to connect to a community for support and that through sharing their data; users can obtain encouragement and praise (Millington, 2014). The theme of mobility and using the apps on the go was also a major marketing goal promoted for the apps (Millington, 2014).

Developers of diet-tracking apps claim the apps can help users achieve various fitness goals. This generally matches up with the users' intended goals. According to a survey of Android users, health apps are used in order to drop weight or boost fitness (Murnane et al., 2015). The actual effects food tracking apps have on users can match these intended goals. According to the survey, about 49.1% of the users said they felt healthier since using a health app and users who used the app more found they had lower stress levels and walked more (Murnane et al., 2015). Another study that conducted interviews with users of food trackers show the effects users experienced was weight loss and food choice changes (Didžiokaitė

et al., 2018). The apps' influence on the user was linked to ongoing usage of the app revealing temporary effects such as losing weight and eating better (Didžiokaitė et al., 2018).

Food tracking apps have been compared to other entry techniques such as pencil and paper, smartphone memos, and diet counseling (Wharton, et al., 2014). One study compared the various food tracking techniques of food tracking apps, pencil and paper, and smartphone memos. The study found all three groups were shown to lose weight, although the weight loss for one group was not significantly different from the others (Wharton, et al., 2014).

Some behavior changing strategies used in fitness apps include allowing the users to set goals and providing caloric tracking feedback and energy balance feedback (Tang et al., 2015). In addition, it has been shown that self-monitoring can lead to better self-management for those with chronic conditions, but patients' food journaling appear to be more important to doctors when it can be integrated with other health data (Kim et al., 2016; Wilde & Garvin, 2007). The patient logged data can be used to motivate patients and improve the communication between the patient and physician (Chung, Cook, Bales, Zia, & Munson, 2015).

### **Unexpected Effects of Food Tracking**

Many food tracking apps lack methods to change users' behaviors in the long run (West et al., 2013). In addition, data entry of meals can be tedious causing users to stop using the apps (Krebs & Duncan, 2015). One unintended effect of using food tracking apps is the unintended emotional effect on patients with chronic conditions (Ancker et al., 2015). Other unintended and maladaptive effects include users not accurately recording the information they are eating, becoming obsessed with body image, experiencing unhealthy dietary restraint, and increasing eating disorder tendencies among those with these disorders (Cordeiro et al., 2015; Eikey & Reddy, 2017; Evans, 2017; Simpson & Mazzeo, 2017).

Popular health apps use some methods to change users' behaviors, but more could be done to enhance the effectiveness of the apps (Azar et al., 2013). Examples of criteria used to assess behavior changing strategies used are the app's assessment, feedback, general assistance, guidelines, and individualized advice to users (Azar et al., 2013). Several studies tested highly rated health and fitness apps and found the apps lacked behavior changing techniques (Chen, Cade, & Allman-Farinelli, 2015; Davis et al., 2016; West et al., 2013). In addition, no health or nutrition professionals were consulted when the apps were designed (Chen et al., 2015). Also, some diet tracking apps lack rigorous evaluation studies (Rohde, Lorkowski, Dawczynski, & Brombach, 2017).

In addition to many food trackers lacking methods to change users' behaviors, users have abandoned the apps for various reasons (Krebs & Duncan, 2015). In a cross-sectional survey sent to 1604 smartphone users, a little over half the subjects had downloaded a health-related app and most who used the apps, stopped their usage (Krebs & Duncan, 2015). Data entry was considered a burden and was reported as a major reason why users quit (Krebs & Duncan, 2015). Another study shows users reported not tracking food in apps in the past because it was too hard, they didn't know their food ingredients, or they forgot to enter in their food (Cordeiro et al., 2015). App features that could help support habit formation suggested by users are completion checks and backup reminders (Stawarz, Cox, & Blandford, 2015).

One study discussed the unintended emotional effect tracking technology had on patients with chronic conditions (Ancker et al., 2015). This study interviewed 22 patients with chronic conditions and seven health care providers who have taken care of patients (Ancker et al., 2015). The patients tracked their personal and health data for management purposes and to better understand their condition. The data aroused both negative and positive emotions (Ancker et al., 2015). The data made some patients feel discouraged or reminded of their sickness (Ancker et al., 2015). Current data tracking technology assumes the users have limitless enthusiasm for tracking when in reality; this may not be true especially for those with chronic conditions (Ancker et al., 2015).

Another unexpected behavior is users not accurately recording the information they are eating despite their awareness of its nutritional value (Cordeiro et al., 2015). Their actual food intake could be different than the food they are entering in on the food tracking app. 45% of participants in a field study reported not recording some food in past food trackers because it was unhealthy or it would exceed their caloric intake for the day (Cordeiro et al., 2015).

An additional unintended effect is the possibility the user could become obsessed with food tracking and body image (Evans, 2017). Neuroticism, sex, and body dissatisfaction were tested as predictors of usage of calorie counters by undergraduates (Embacher Martin, McGloin, & Atkin, 2018). 491 participants were surveyed, and the study found the factors of being female and having body dissatisfaction were predictors of calorie counting usage (Embacher Martin, McGloin, & Atkin, 2018). Another study shows women were more engaged with tracking their diets than men (Abhishek, Downs, Kato-Lin, & Padman, 2016).

In an additional study, 345 undergraduate women were surveyed about eating disorder behaviors and calorie tracking (Simpson & Mazzeo, 2017). The results showed consistent calorie counting was linked with dietary restraint and eating concerns. Using calorie counters may increase the user's anxiety about their intake of calories (Simpson & Mazzeo, 2017). In addition, caloric tracking may be concerning for those more likely to develop eating disorders (Simpson & Mazzeo, 2017).

Technology and media can be a factor in developing eating disorders and low body satisfaction (Eikey & Reddy, 2017). Food tracking apps can also have unintended negative effects on users with eating disorders (Eikey & Reddy, 2017). Researchers examined unintended effects of food tracking apps in regard to eating disorders. They interviewed 16 women who used food tracking apps and had a history of eating disorders (Eikey & Reddy, 2017). The women interviewed reported using their food tracking in an unhealthy manner. They reported experiencing obsessive logging throughout the day (Eikey & Reddy, 2017). The app would emphasize numbers worsening their eating disorder actions. Some users did not report data so they could burn more calories than recorded (Eikey & Reddy, 2017). Other users

compensated for exceeding their calorie budget by vomiting or not eating as much the next couple days. When users went over the calories for the day, they experienced shame (Eikey & Reddy, 2017). In addition, when users went over their daily calories, the calorie display changed to red and that caused anxiety among participants (Eikey & Reddy, 2017). Instead of a number focus, the app could be improved through encouraging nutrition. There could also be a weight gain feature for those who need that feature (Eikey & Reddy, 2017).

As food trackers continue to grow in popularity, it is important to understand the full effects that they can have on users' eating habits. As research suggests, there are unintended consequences from integrating these food trackers into users' daily lives (Ancker et al., 2015; Cordeiro et al., 2015; Eikey & Reddy, 2017; Evans, 2017; Simpson & Mazzeo, 2017). More research is needed to understand unintended effects on users' eating habits. Design changes are needed in order to improve food tracking for users.

A research question still not fully explored is: "Does caloric tracking in food tracking apps have unintended effects on a user's eating habits and are there design implications from these effects?" Further analysis of the unintended effects on a user's eating habits during and after using a food tracking app is needed. Users generally start using food trackers with intended goals in mind. In my research I want to explore possible effects that are unintended from the user's perspective and note the design implications to avoid these unintended effects.

## **Chapter 3**

### **Method**

Qualitative analysis is the most appropriate method to use for my study because I want to collect data on users' experiences with food tracking applications. Qualitative analysis can be used to interpret detailed narratives and interviews allow for in-depth and purposeful data from users' accounts (Smith, 2007). In my study, I wanted to build trust between the user and me as the researcher. Through interviews, I was able to obtain one-on-one time where the subject felt comfortable sharing their experiences with me. An interview was the most appropriate form of data collection because I was able to record detailed data by asking open-ended questions. I followed my standard interview questions but was able to ask follow-up questions if I needed clarification or more context on the user's response. In addition, I was able to hear the user's tone of voice and observe their hesitations and emotions when conducting the interview. By observing the user's responses and asking adaptable follow up questions, I was able to better understand each user's personal experience with the food tracking app.

### **Subjects and Recruitment**

In this study, I use existing food tracking applications to conduct use-inspired basic research (Stokes, 1997). Use-inspired basic research involves analyzing current technology and its current uses and seeking improved understanding (Stokes, 1997). My goal was to gain an improved understanding of users' interactions with food tracking applications. I networked with users of food tracking applications and used convenience sampling to obtain 20 subjects to participate in my interviews.

Subjects were contacted in person or by phone to be in the study. Subjects then signed a consent form, which provided their permission to be a part of the research. In addition, subjects were asked if they

had used or were currently using a food tracking application and if they were above the age of 18. This determined their eligibility for the study. I reiterated that the interview was voluntary and ensured that subjects were aware that they were able to withdraw or skip interview questions if they chose.

### **Data Collection**

The interviews were conducted in a local area in person or by phone. I interviewed one subject at a time based on their availability. First, I asked the subject if they were ready to begin the interview. Then, I informed the subject that I was starting to record their answers through note taking and voice recording. Next, the subject was read one interview question at a time. I recorded the subject's answer to the question and repeated these two steps until all of the interview questions were asked. If the subject said something that was interesting or unclear, I asked follow-up questions to the standard questions. The interview ended when the subject was finished answering all of the questions. Finally, I stopped the voice recorder and thanked the subject for sharing their experience.

### **Interview Questions**

1. Do you currently use a food tracking application? Which one?
2. Have you used a food tracker in the past? For how long and why did you stop using the application?
3. What is the name of the food tracking application you used?
4. Describe the intended goal you wanted to achieve through using the food tracking application.
5. Did you use the application regularly i.e. every day for every meal, or only occasionally?
6. Describe a situation when you used the calorie tracking feature in the application.

7. Describe a situation where using the food tracking application had a positive impact on your eating habits.
8. Describe situations where using the food tracking application had unintended effects on your eating habits.
9. Did you encounter a situation where you skipped recording your food intake? Did you skip recording food by accident or on purpose?
10. A. If you skipped recording food by accident, describe a feature that was missing from the application that might help you remember to record your food intake.  
B. Did you ever purposely skip recording food because you didn't want the snack/meal added into your daily intake?
11. Did the caloric tracking feature make you feel anxious or guilty? Did you experience any obsession with the application?
12. Did the caloric tracking cause any dietary restraints? If so, do you consider the dietary restraint unhealthy or healthy?
13. Overall do you feel you ate healthier foods when using the food tracking application?
14. Have you experienced any long-term effects from using the application?

### **Data Analysis**

I used thematic qualitative analysis to analyze the data (Smith, 2007). First, I familiarized myself with the data by listening to the recordings and reading the interview notes (Smith, 2007). Then, I coded the interview notes by looking for patterns among key words and themes in the subjects' responses. After I coded their responses, I analyzed the patterns and grouped the similar codes together before reviewing the themes and defining them (Smith, 2007). Then, I conducted my final analysis. I used semantic theme analysis by recording the subject's responses and interpreting the subject's meaning through what they

explicitly said. I also used descriptive theme analysis by reporting patterns I found within the data (Smith, 2007). A benefit of my study is gaining knowledge on food tracking applications and how they affect users. Software developers can use my research to improve the design of food tracking applications for the future.

## Chapter 4

### Results

The research question I focused on was, “Does caloric tracking in food tracking applications have unintended effects on a user’s eating habits and are there design implications.” After analyzing the data, there were unintended effects found as well as maladaptive effects. Maladaptive effects vary slightly from unintended effects. According to Merriam-Webster dictionary, maladaptive is defined as, “marked by poor or inadequate adaptation.” (maladaptive, 2019). Some of the effects the users experienced can be considered maladaptive because they were not using the food tracking app properly.

In total, 20 subjects were interviewed for the study. The subjects included 6 males and 14 females whose ages ranged between 20 and 60 years old. The first cycle of coding I conducted was based on descriptive coding. This type of coding uses descriptive codes to summarize the subjects’ response into shorter phrases (Miles, Huberman, & Saldana, 2014). The second cycle of coding involved merging themes. In this phase, codes changed into patterns (Miles et al., 2014). After the coding steps were completed, the themes were totaled. Counting themes is one strategy for generating meaning in qualitative data analysis. (Miles et al., 2014).

Overall, the food tracking app that was used the most among the subjects was MyFitnessPal. The second most popular app used was the Fitbit app. Other apps used were Map My Walk, Lose It!, and MyPlate.

**Table 1. Food Tracking Apps Used By the Subjects**

Name of App	Number of Subjects
MyFitnessPal	15
Fitbit App	2
Map My Walk	1
Lose It!	1
MyPlate	1

In order to understand the unintended and maladaptive effects of food tracking apps on users' eating habits, it is important to understand the intended goals for using the apps. The top five themes of the subjects' intended goals for using the food tracking apps were to improve self-awareness, lose weight, discover food intolerances, maintain weight, and gain muscle.

**Table 2. Subjects' Intended Goals for Using the App**

Goal	Count
Improve Self-Awareness	13
Lose Weight	6
Discover Food Intolerances	2
Maintain Weight	2
Gain Muscle	1

### **Improve Self-Awareness**

The reason most subjects used the food tracking app was to become more aware of their eating habits. This includes learning how many calories they eat in a day, what types of food groups they eat the most, or what a healthy proportioned day looks like. One subject stated,

*“I wanted to learn how many calories I was intaking.”*

Another subject claimed,

*“I wanted to track my calories and nutrition.”*

Learning about one's calorie intake and one's nutritional information was a common goal among the subjects. In total, 13 subjects stated one of their goals was some form of self-awareness.

### **Lose Weight**

Another reason subjects used the apps was to lose weight. This category includes subjects' answers involving losing weight or cutting calories. One of the subjects said,

*"I was trying to lose 10 pounds. I was eating snacks all day so I was hoping it would help me cut down on that."*

Another subject stated MyFitnessPal included functionality to support this goal when they initially set up the app. The app had the user enter in her weight goal and the app calculated a calorie limit. The goal of losing weight was mentioned by six of the subjects interviewed.

### **Discover Food Intolerances**

The third most popular goal of using food tracking apps is tied between discovering food intolerances and maintaining weight. Two subjects stated they started using the app to discover foods in their diet that were giving them stomach aches and pains. By logging every item they ate throughout the day, they hoped to narrow down which foods were making their stomachs hurt. One subject described her goal,

*"When I didn't feel well from the foods I was eating, I wanted to see which foods were causing the issues to see what I was allergic or intolerant to."*

This goal was significant to these two subjects because they wanted to improve their daily lives by identifying and eliminating certain foods.

### **Maintain Weight**

The other third most popular goal among the subjects was to maintain weight.

One subject explained,

*"I wanted to maintain caloric intake without gaining any weight."*

The subjects who mentioned this goal seemed happy with their current weight and did not want it to fluctuate. By using the application, they could see how many calories they needed to eat to keep their current body weight.

### **Gain Muscle**

Only one subject mentioned the last goal. He was using the food tracking app in order to gain muscle. He claimed,

*“My intended goal was to watch my food intake so that I could get the right amount of everything to build muscle most efficiently and stay lean.”*

The subject was tracking various food groups such as proteins in order to gain muscle.

The subjects were asked various questions about how the food tracking apps made them feel, how they used the app, and the effects the app had on their eating habits. The interview guide can be found in the method section. There were numerous effects the subjects discussed and there are design implications that can improve their experiences. The five most popular effects were they became aware of unhealthy food but still ate it, experienced unexpected guilt, experienced unhealthy eating, learned new information about their diet, and changed their eating habits based on data entry.

**Table 3. The Unintended and Maladaptive Effects on the Subjects' Eating Habits**

Unintended Effect	Count
Became Aware of Unhealthy Food but Still Ate It	6
Experienced Unexpected Guilt	5
Experienced Unhealthy Eating	3
Learned New Information about Diet	3
Changed Eating Habits based on Data Entry	2

### **Became Aware of Unhealthy Food but Still Ate It**

Six subjects claimed they ate various foods that were not included in their tracking. These subjects admitted they skipped entering in certain foods into their daily consumption on purpose. Their reason for skipping was the food they ate either would push them above their daily caloric limit or other food group limits. The food was still being consumed, but it was not being reflected in their tracking. One subject stated,

*“I did not want to add the food I was eating to the daily intake.”*

Another subject admitted,

*“If I ate cookies, I can’t put that in. It will throw me off for the day. When I’m bad I will never put it in.”*

This effect is maladaptive because the users were not using the application properly. It is unwanted behavior from the application developer’s side and the user’s side. If the user is not honestly entering in their diet, the app will not have the correct totaled calories or food groups. The users were aware of the unhealthy nutritional value of the food but ate it anyway.

### **Experienced Unexpected Guilt**

Subjects admitted using food tracking apps caused them varying degrees of anxiety. Although dieting is expected to cause some degree of anxiety and guilt, a large amount of these feelings can be unintended from the user’s perspective. The users included in this category are those who’s guilt was unintended.

This category includes users who admitted experiencing stress, anxiety, or guilt. This category can also be considered maladaptive because the users adjusted poorly to the application.

One subject described,

*“The pre-warning makes me anxious even though I am not even close to the limit yet... The warnings seem too early.”*

The subject described receiving the warning previous to exceeding his allotted calories seemed too premeditated and caused him anxiety.

Another subject admitted,

*“I felt stressed when I realized I did not have a lot of calories left and I wanted something else to eat and realized I would go over.”*

This subject felt stress when her body was still hungry, and the calorie limit was already reached.

A different user stated,

*“I never liked when I went over my daily calorie limit. I felt like I was eating enough or a normal amount and then it would show up red and say you’re eating too much... When I was eating too little, it also showed up red and that did not make me feel good.”*

This subject stated any time the app showed red it did not make her feel good whether she was above or below her allotted calories. These feelings were unintended from the users’ side, but experienced while using the app.

### **Experienced Unhealthy Eating**

Three subjects experienced the unintended effect of unhealthy restrictive eating. They admitted that the dietary restrictions they were experiencing from the app were not healthy. One subject stated,

*“I wanted my calories to be as low as possible... so I under-ate sometimes.”*

Another stated,

*“Any time I saw calories rising up to the limit or I went over, it made me anxious and made me want to eat a lot less the next few days.”*

This user admitted seeing his calories go above his daily consumption caused him some anxiety and contributed to unhealthy dietary restrictions days after.

A third subject claimed,

*“At one point, I decided to eat only 1,200 calories a day and I looked like a skeleton.”*

This subject’s body height and activity level suggested she eat over 2,000 calories a day. These three subjects experienced unhealthy eating patterns while they were using the food tracking app and they were undesired making them an unintended effect.

### **Learned New Information about Diet**

Three subjects stated they learned a new piece of information about themselves that was not initially intended from using the food tracking app. This unintended effect is overall a positive finding because the information discovered was important and eye opening for the subjects. One subject stated the app helped him realize that his diet was not balanced across the various food groups. Another subject claimed the app helped her pay more attention to her fats and cholesterol. A third subject stated,

*“I realized I did not eat enough fruits and vegetables... I did not get the app for the fruits and veggies ordeal... for me that was eye opening.”*

The types of information that was learned through using the application was not a part of their initial goal in using the application but was useful to them.

### **Changed Eating Habits based on Data Entry**

Two subjects experienced an unintended effect in their eating patterns. They changed an aspect in their eating patterns because of the app’s data entry design. One subject stated she started eating in portions shortly after using the app.

She stated,

*“I was more cognizant of portion size because I had to enter it into the app. Before I had never paid attention to that.”*

MyFitnessPal asks the user for specific portions and measurements, so the subject began measuring her food in order to be precise. Another subject stated she was more inclined to eat something that was easy to find in the food database. She stated,

*“I felt I was more inclined to eat something that was easy to find in the app and I could track. I like to be very precise.”*

She went in with the intention of eating her usual meals but changed her eating based on the app.

### **Other Findings**

Seventeen out of 20 subjects used the application every day during their period of use. Two subjects admitted they initially started using the app every day but eventually went to occasional usage. One subject stated that his or her usage was not constant. Six of the subjects used the application at the time of their interview. Fourteen subjects had used the application in the past. The duration of when the subjects used the applications varied from one week, a few weeks, 2-3 months, 4-5 months, a year, and a year and a half.

Suggestions users had for the food tracking apps ranged from features the applications already include to new ideas for their design. Some of the suggestions are already built into the applications such as MyFitnessPal were food scanners and pre-set meals. In addition, eight of the subjects stated they would like to have some type of notification to remind them to track their food at various times throughout the day. This feature is already built into various food tracking applications. These types of features are central to the application and should be emphasized or even pointed out to the user.

New ideas suggested by the subjects were the apps should have the ability to keep track of food intolerances and include more options for entering in portion measurements. One subject stated the app could have a picture of food in a standard bowl to help him understand their portion sizes better. Another

subject wanted the ability to enter food based on a different measurement other than weight. These are some features that users wanted to see improved in the apps in the future.

## Chapter 5

### Implications and Conclusion

Some of my findings concur with other studies such as the discovery that users of food trackers may not accurately track unhealthy foods (Cordeiro et al., 2015). This finding agrees with the findings from another study where 45% of participants admitted to not recording food because it was unhealthy or would exceed their calorie limit (Cordeiro et al., 2015). In addition, various participants in my study reported that using the food tracking app made them feel guilty. This type of response to food tracking apps has been reported before (Simpson & Mazzeo, 2017).

During the analysis phase of my study, I discovered that some users were experiencing behaviors that were derived from a misuse of the food tracking application. Users who became aware of unhealthy food but still ate it and users who experienced unexpected guilt fall under this category. These behaviors are maladaptive because the users were adapting to the application poorly. This behavior was unintended from their goals and is a result of not using the application correctly.

Various design changes could be made in response to the participants' feedback from my study. The five unintended and maladaptive effects participants experienced were that they

- became aware of unhealthy food but still ate it
- experienced unexpected guilt
- experienced unhealthy eating
- learned new information about their diet
- changed their eating habits based on data entry

Possible design implications are changing colors that are used in the app, expanding the applications' food databases, changing the reminder settings in the app, keeping track of food intolerances, and promoting awareness of important features.

Three different subjects mentioned that the red coloring of the calorie counter made them feel anxious. A design change that could be made is to change the coloring of the calorie counter from red to a less visibly alarming color. Red is associated with emotions such as anger, fury, and passion (Hanada, 2018). Another solution could be to allow the user to select the limit for when the calorie counter turns red. Some users may not feel alarmed or concerned when they exceed their calorie intake limit by a hundred calories, but rather when they exceed their intake limit substantially.

Another design change that would benefit food tracking apps would be to expand the food databases. Multiple participants mentioned that data entry was tedious, and others wanted more restaurants included in their selection. Users would have an easier time entering in meals if the apps include more restaurants and food selections in the database. Another study found that extensive databases that provide calories and health-related feedback were significant for the users' satisfaction (Tang et al., 2015). Developing easier ways for users to estimate their food measurements such as using pictures to compare their servings sizes to might be a solution for tedious data entry.

Five users experienced unexpected guilt and three engaged in unhealthy eating. To combat this, the applications could allow users to adjust the settings in order to choose when they receive warnings about exceeding food group limits and calorie limits. For users who are more sensitive to the warnings, they may want the app to alert them when they are closer to their threshold than others. By allowing the user to choose when they want warnings to appear, that allows the app to adjust to different users' experiences and preferences. Another study suggested that food tracking apps should focus more on nutrition rather than numbers (Eikey & Reddy, 2017).

Additionally, two of the subjects in this study used food tracking apps to identify possible food intolerances. In order to expand to these types of users, developers could incorporate a feature in food

tracking apps where users could flag certain foods that caused them digestive issues. The app could maintain a list of flagged foods in order for the user to identify common ingredients that gave them discomfort. One study created an app called TummyTrials to help users with irritable bowel syndrome identify their trigger foods, and the subjects overall had a positive experience (Karkar et al., 2017).

Lastly, there were features already within the apps that subjects were recommending for future features. These features included notifications, food scanners, and preset meals. There is hidden value in these features, and people may be more satisfied with food tracking apps if they were made aware these features already exist in the app. Possible design changes to emphasize these features include pointing out these features in an introduction tutorial or making them more central to the home screen's interface. Onboarding tutorials are important and when they are poorly designed can be a reason why users stop using free apps (Petersen, Thomsen, Mirza-Babaei, & Drachen, 2017).

### **Limitations**

Regarding the limitations of my study, my results may not represent the population as a whole or control for outside variables. External validity addresses whether my results can be generalized to more people, times, and settings (Mitchell & Jolley, 2012). I used a sample size of 20 people, 14 females and 6 males. They were all from the same general location of State College or Pittsburgh, so my results may not be applicable to all users of food tracking apps. In addition, since I conducted the interviews outside of the users' real time usage, my study may lack realism of context and precision of controlling variables. (McGrath, 1982). Regarding my method of analysis, I was the only researcher conducting the qualitative analysis in my study. This may have affected the coding validity since making accurate inferences about the meaning of the subjects' experiences was my responsibility and was subject to solely my interpretation (Crittenden & Hill, 1971).

## Conclusion

In conclusion, my research can be used to improve the future design of food tracking apps. I recommend that users of food tracking apps be aware of possible unintended and maladaptive effects the apps can have on them. I believe it is important for users to seek help from a dietitian or nutritionist if they experience any undesired feelings or eating habits that may be unhealthy. After conducting my study, the participants' experiences led me to discovering areas for improvement in the apps. Future researchers can build on my study and continue to learn about how food tracking apps are used to improve their usability and users' experiences. More research is needed to be done on the long-term effects of wellness tracking apps on users as well. Currently, users are integrating new apps into their everyday lives without hesitation. Researchers need to continue to strive to understand the unintended and maladaptive effects these apps can have on users. By understanding how technology affects users and society as a whole, our world can grow to become more self-aware and cognizant about the consequences of technology.

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## Academic Vita of Lauren Doutt

lmd5596@psu.edu

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### Education:

The Pennsylvania State University, University Park

- Schreyer Honors College
- Major: Information Sciences and Technology Design and Development
- Minor: Security Risk Analysis
- Graduation: Spring 2019

### Achievements and Awards:

Dean's List 2015-2018

National Merit PPG Industries Foundation Scholarship

H. George Kile Memorial Scholarship

PNC Technologies Scholarship

Evan Pugh Junior Scholar Award

Evan Pugh Senior Scholar Award (top .5 percent of respective class)

### Work Experience

#### Learning Assistant

- Assisted as a Coach for IST 242 Intermediate & Object-Oriented Application Development
- Assisted as a Coach/Grader for IST 311 Object-Oriented Design and Software Applications

#### PNC Digital Intern

May 2018-August 2018

- Performed user acceptability testing on the PNC mobile app
- Groomed user stories for the locator feature
- Discovered bugs in iPad landscape app and wrote user stories to address the issues
- Researched and brainstormed for Amazon Alexa's integration with PNC
- Created an inventory for test devices

#### Bayer IT Mobility Intern

May 2017-August 2017

- Troubleshooted iDevices for Bayer's US Division
- Worked with MDI and Airwatch to enroll devices with company applications
- Created Excel survey reports and presented them to third party companies
- Led a loaner Mifi program to improve user experiences
- Helped implement TravelPass
- Assisted in the T-Mobile test pilot