Digital Self-Development:

How Mobile Fitness Apps and Tracking Devices Aid in the Development of Physical Skills

By

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Abstract

As personalized digital technologies have developed over the past decade, so to has the desire among some people to use mobile applications and tracking devices to capture data about their activities for the purposes of personal development. Current research considers The Quantified Self, personal informatics, design and behaviour change as ways to examine how these new personal technologies are used and implemented. Informed by Self-Determination Theory, this research study examines how six members of an online self-development platform use tracking applications and devices in order to determine whether these technologies aided them in building upon and acquiring new physical skills. Qualitative data obtained from semi-structured interviews with each participant was examined. The findings from these data suggested that mobile tracking applications and devices can successfully help users develop new physical skills, so long as certain criteria are met, such as adequate design, informative communication, and ease of use. Further research can build on these findings as technologies become more advanced and provide richer sets of personal data and find new ways to bring about successful behaviour change and skills acquisition.

CHAPTER 1 – Introduction

1. Introduction & Research Question

In the past 10 years since the introduction of Apple's iPhone, as well as the increased market saturation of subsequent smart phones and other wearable computing devices such as smart watches, the fitness industry has seen an influx of new ways for people to engage in physical activities including methods that use digital-based fitness instruction applications and services. This instruction has come in the form of digital, mobile-based applications – programs that live and breathe on smart phones. These mobile applications allow for fitness app users to record, track, document and analyze their physical activity. As the technologies embedded in these smart devices have become more sensitive, powerful and capable, through features such as sensors, GPS, cellular connection, altimeters, accelerometers, and heartbeat sensors, to name a few, users are able to use these devices to track, record and measure their physical activity in new and novel ways. Through the way the data is collected and interpreted thanks to developments in algorithms and on-device computation, users can gain further insight into the development of their physical fitness abilities and achieve desired behavioural changes.

Since the adoption of these technologies is new, research into the behaviour of users of these devices is still being established. My literature review, therefore, seeks out to identify major themes in the existing research to understand where the focus has been – and where future research needs to go. The major themes discussed in this literature review include: The Quantified Self, Privacy, Technology Adoption, Behaviour Change & Motivation, Gamification, and Communication & Usability. What ties these themes together is the connecting thread of Behavioural Design, or how a mobile application is built, planned and designed to communicate and bring about behaviour change from a user. My literature review includes a consideration of

the benefits of these emerging technologies, as well as some of the limitations and critiques that have be applied to them. As I discuss below, the literature review sets up the main research question for my Capstone project: **How do mobile fitness applications and tracking devices aid their users in the development of real-world physical skills?**

Following the literature review, my Capstone moves to my research design and methodology, first looking at the online self-development platform, *The Strenuous Life* (TSL), which provides a helpful environment in which to assess users and their app use as they seek to develop physical skills. Here, a brief case study of TSL provides details of the platform and the context for my research, before moving on to an explanation of the data collection and qualitative analysis of the data. A qualitative research design provides my Capstone with an appropriate examination of the data provided by semi-structured interviews of members of TSL. While much of the current research into behavioural change and design considers quantitative results, for my Capstone a qualitative analysis provides richer opportunities to examine not just the "what" but also the "why" and "how" of user experiences with fitness apps. I adopt a semi-structured, flexible approach in my interviews that allows for the participants to expand on their answers, or for new responses to be revealed through alternative questions and discussions. The methodology chapter concludes with a brief discussion at the development of the interview questions as well as the process of data collection and analysis.

My Capstone's findings chapter discusses the important themes that emerged from the interviews, including quotes from the interviews that help illustrate each theme. Though the themes used for coding the interview were numerous, the emergent themes were distilled into six overall themes: Technology Adoption & Behaviour Change, App Design & Use, Values & Goals, Skills Development, Social Comparison, and Tracking. These themes were used to guide

my final findings and discussion. Overall, based on these findings, I conclude that mobile fitness apps and tracking devices are highly useful and helpful in providing unique ways for users to develop physical fitness skills, so long as certain criteria are met such as adequate design, informative communication, and ease of use.

In my conclusion, I acknowledge both negative and positive observations from the interviews, ultimately coming to an understanding that overall, the regular use of fitness apps and the motivation found in the ability to review one's progress, and to be reminded to continue to exhibit positive effort, does result in positive behaviour change. Subsequent research therefore can continue to build on relevant literature, including the findings of my research, even as technology advances and provides more nuanced feedback on a person's activity.

This chapter introduced my Capstone focus and research design and provided a summary of my chapters. In the next chapter I discuss the current literature on app use and behavioural design. This literature review provides an introduction to research undertaken over the past 10 years. To begin, I provide an overview of my search methodology before moving on to the overall discussion of the literature.

CHAPTER 2 – Discussion of the Literature

2. Literature Review Methodology

This literature review builds a foundation for my Capstone Research Project by providing insight into existing research on how mobile fitness applications can help users in the development and practice of real-world skills. My search criteria include a focus on recently published articles, with the aim of including those no older than 2007. Some exception was given if the content was inherently relevant and informative. Similarly, the aim was to include articles

that distinctively considered a) behaviour change; b) mobile (fitness) apps; and c) survey and questionnaire methodologies to inform my own research. While many articles expanded far into other themes of behavioural psychology, I was careful to only consider those that incorporated digital technologies into behavioural research. There is also considerable research into the area of the Quantified Self (QS). While Quantified-Self tracking goes back to the 1970s (McClusky, 2009) and personal tracking devices having been popularly introduced in the 1970s (Who We Are, n.d.), my research is specifically focused on mobile applications. Since the iPhone was first released close to 13 years ago (in 2007), I decided to restrict my consideration of Quantified Self, biometric and mobile application themed research to the past 10-15 years, to remain up-to-date and relevant.

Furthermore, since tracking technologies in mobile devices are now available in virtually all global markets, an article's country of origin was irrelevant. However, I found that bias toward certain devices and technologies did seem to coincide with the country in which a study was published. For example, studies originating in China favoured Chinese-developed apps, while western countries such as the U.S.A. or U.K. favoured European- or American-based apps.

During my research, I included the following major key words, organized by three search themes: *App Design, Behaviour, and Health & Tech*. *App Design* refers to articles that focused on key design features that affect how an app is used, provides metrics, or collects data. *Behaviour* refers to articles that presented findings on people's actions, whether influenced by something like a mobile fitness app, or more traditional environments and contexts such as sports, coaching or testing, while also considering traditional research areas of psychology and motivation. Finally, *Health & Tech* refers to research into digital technologies developed for specific health and/or fitness applications.

To collect this literature, I employed a systematic search process, as outlined by Oliver (2012). This began by determining key words to guide my library search. The key words used in these themes are presented below:

App Design

- Gamification, design, notifications, data collection, surveillance capitalism, privacy, tracking, quantified-self, privacy, engagement, social networking.

Behaviour

- Sports psychology, motivation, behaviour modification, behaviour design, fitness, physical therapy, skills development, physical testing, long-term motivation, motivational information system, goal-setting, goal-orientation, self-tracking.

Health & Tech

- Wearables, smartphone design, fitness trackers, monitor, sensors, self-efficacy, mobile healthcare, athletic ability, measurement.

I then conducted a search through UofA's Library Search function and Google Scholar. I considered close to 80 sources, including peer-reviewed articles, books, blogs, and mainstream magazine articles. I sorted through these materials to determine what to include in my literature review. I chose articles based on inclusion and exclusion criteria. My inclusion criteria included specific instances of app design, behaviour, fitness applications of mobile apps and behavioural design. I excluded articles based on criteria such as a lack of scientific rigor, lack of access, or if the study was not relevant to my study. Some examples of this included apps that were not

fitness related, or studies that were too focused on other themes of big data and healthcare, rather than tracking the activities of users. Also, I excluded articles because of their lack of depth or relevancy, such as articles from popular health and fitness magazines and websites.

This process resulted in 50 articles for my annotated bibliography. I then added an additional five articles to address certain gaps that were identified during the discussion of my findings as well as in further examination of the current literature, bringing the total number of articles reviewed to 55. In the next section, I present the findings of my review of the literature. For the purposes of my research, this literature is divided into several themes: The Quantified Self, Privacy, Behaviour Change & Motivation, Gamification, and Communication & Usability. I also included literature to inform the overall theoretical framework applied in this project.

3. Theoretical Framework

Many articles in the literature regarding the adoption and use of mobile fitness apps and tracking device draw on Self-Determination Theory (SDT). As I describe below, SDT is an appropriate way to frame this research project. Essentially, SDT looks at people's psychological needs as the basis for their self-motivation. These include: 1. Competence; 2. Relatedness; and 3. Autonomy. Two forms of motivation that come out of these needs are Intrinsic and Extrinsic Motivation. Intrinsic Motivation (IM) reflects a desire to seek out novelty and challenge, extend personal capacities, and to learn. In contrast, Extrinsic Motivation (EM) reflects a focus on performance to attain an outcome outside of one's self (Ryan & Deci, 2000). IM stems from something in which a user shows interest, such as specific fitness goals, while EM results in actions that are required or meet certain expectations, such as an external, standardized fitness test.

Another way that SDT is employed in studies of technology and behaviour is the Motivational Technology Model (MTM) developed by authors Molina and Sundar (2020). They argue that "based on MTM, the features of technology that afford interactivity, agency and choice of modality will fulfill users' needs for relatedness, autonomy and competence" (Molina & Sundar, 2020, p. 3). In other words, their research asks: what kind of technological features does an app employ to keep a user engaged at a strong enough level that encourages long-term use and help achieve desired behaviour change?

Despite these applications, the concept of SDT is partially contested in the research literature. For example, Attig et al. (2018) highlight how individual usage motives affect how someone uses an activity tracker. While they do reference the value of SDT, their research importantly found that users can be both intrinsically *and* extrinsically motivated simultaneously as opposed to one or the other, and that the balance of both varies between users. Eyal (2013), however, defines SDT as something that "identifies a belief in one's own freedom to choose as a key requirement for sustained motivation" (para 8). Eyal is less concerned about extrinsic motivations, focusing more on elements of perceived behaviour control, which will be discussed in my later chapters. Furthermore, Ryan & Deci (2000) help clarify SDT by describing how it can be used to explain people's psychological needs as the basis for their self-motivation, as expressed in factors like Competence; Relatedness; and Autonomy. I discuss these different ways to frame and apply SDT in further detail below.

A second useful theoretical framework for my project is the Technology Acceptance Model (TAM). TAM is used to help analyse how users accept, and end up using, a new technology. When faced with a new technology such as a fitness app, the model assumes a user considers the app's usefulness as well as its ease of use when deciding whether to use the technology (Lee et

al., 2003). The concept of "usefulness", when used in this way, helps in understanding whether a user is able to adopt a technology into their approach to problems they are attempting to solve, including those related to their fitness levels and personal health. These areas are considered in the QS movement, which I discuss in the next section.

4. The Quantified Self (QS)

A large body of literature examines how people use apps to gauge their fitness levels and daily activity, specifically regarding behavioural change and behavioural design, communication, and sociability. After introducing my general theoretical framework, it is important to consider the roots of the modern fitness app, namely, the "Quantified Self" (QS). First, we must clarify what QS is and what it is not. Many people engage in some form of data tracking at some point in their lives. This can take place on very minute and casual levels. Consider a trip to the dentist office, where a hygienist asks about your brushing history, to which you might answer, "yes, I do my best to brush at least twice a day and floss, though I occasionally skip a few days here and there." At its core, this answer reveals a very high level of self-tracking for the benefit of dental health. This kind of tracking could also be found in general recollections of eating and exercise habits, how much television you watch, or how many times you have had to stop for gas over the past week. Often, passive recollection of data suits the average person's needs with a vague representation of their general health, well-being or perhaps their financial status. However, there are some people who take the tracking and collection of their personal data very seriously, in order to know as much about themselves as possible. These individuals use formal methods and tools, such as robust spreadsheets and recording software, to collect and analyse data about their activities and behaviours down to an increasingly granular level. At times, this personal data is used by these people to motivate certain behaviours or behavioural changes – a practice captured

in the Quantified Self movement. This includes the tracking and interpretation of very minute sets of data that considers small increments of change, to larger sets of data that consider general improvements over time.

Though digital personal tracking still has the impression of a new and growing phenomenon, the QS movement has in fact been around for some time. Many researchers have pointed to a study from 1970 as the start of granular data tracking. As discussed in a *Wired Magazine* article from 2009, at that time biomechanical researcher Richard Nelson from Penn State made a connection between how long a runner's stride was in contact with the ground and how fast the athlete was running. By collecting data about the length of time of contact between a runner's foot and the ground, an individual could strongly estimate the runner's speed (McClusky, 2009). This presented an early example of how QS activities (personal data tracking) could be used to analyze behaviour in the area of health and fitness. Nike and Apple would later build upon Nelson's research in the development of their Nike+ application that combined sensors, an iPod and specialized Nike running shoes to track a runner's speed, pace, distance, and time. As personal trackers became more readily available to the public, a community of users gathered online to share their interest and best practices in a movement that has been described as "self-knowledge through numbers" (What is the Quantified Self?, n.d.). This kind of self-knowledge is further discussed in this review under themes of control, awareness, progress, recovery, frequency, creative expression, and most interestingly as it applies to this research, the development of fitness skills.

The purpose of the QS movement can be understood as a way that people can better understand themselves and make better informed decisions about their behaviours based on their personal goals. Other terms that are helpful to understanding this phenomenon include *Personal*

Informatics or *Personal Analytics.* As Choe et al. (2014) describe it, "through the knowledge of one's data, it becomes possible to reflect on one's activities, make self-discoveries, and use that knowledge to make changes" (p. 1). The act of reflecting on data, combined with the ability to make personal discoveries about one's habits and actions, is what many find so appealing about the QS movement. Indeed, we can learn a lot from the development of the QS movement and the relationship people have with data about themselves. Often, people are interested in learning how to use this data – as well as what it tells them about their behaviours, habits and activities. As advancements in technology lead to more widespread use of QS methods and techniques, we can see the QS movement focusing on the "intimate relationship" an individual has with their data. (Swan, 2013), as well as the relationship they have with the devices and technologies they use to collect and analyse that data. This intimate relationship speaks to the heart of the QS community, where the act of personal data collection and interpretation becomes tied to fundamental values that people hold about themselves, such as autonomy, solidarity and authenticity (Sharon, 2017). Whether and how these values manifest in the results of self-tracking, however, is disputed and may vary depending on the community and individuals involved.

This discussion around the links between personal data and fundamental values, it must be acknowledged, does seem to bring a sort of mystical quality to the revelations that some users believe QS practices may bring to the dedicated user. The desire for some users is to use QS as a means to ultimately solve their most personal problems, such as improving the quality and duration of one's sleep using recording devices and measurements of movement, or tracking one's pacing and movement to support the goal of becoming an athlete who can run faster or longer.

However, this faith in the ability of QS has its critics; for example, as Hoy (2019) points out, “the allure of the quantified self is a guess that many of our problems come from simply lacking the instruments to understand who we are” (p. 95). Wang et al. (2015) similarly found that simply wearing a personal data tracking device was insufficient in boosting physical activity among a group of research participants. In other words, collecting and analysing a collection of data does not automatically lead to action or meaningful behavioural change. Rooksby et al. (2014) make a helpful point here, observing that “people [are] not changing their behaviour because of a technology but [rather are] using technology because they [want] to change” (p. 2). This is an important observation that helps guide my research into the role of app and device use in bringing about lifestyle change. But first, I discuss some of the critiques of the QS movement and associated personal data tracking activities from the perspective of privacy and surveillance concerns.

5. Critiques: Privacy and Surveillance

Before moving on to the features of technology adoption and methods of implementing mobile digital tools for behaviour change, it is integral to raise concerns related to this topic, such as user privacy and surveillance. One of the biggest questions raised is the relationship of fitness trackers and the privacy of data. Fereidooni et al. (2017) consider this issue and whether tracking devices are limited in their technological capabilities when it comes to protecting users. Some applications take into consideration “tensions that exists within applications seeking to share route information and simultaneously concealing sensitive end points” (Hassan et al., 2018, p. 3). If users do not feel protected, this in turn affects their long-term behaviours - a detriment to both the app developers and the users (Fereidooni et al., 2017).

Note, however, that for members of an online community or social network, app features such as sharing route information with group members are considered a part of successful behavioural change techniques – a benefit rather than a shortcoming of an app. App developers are aware of this potential benefit; for example, Hassan et al. (2018) highlight that privacy features such as "Endpoint Privacy Zones" (p. 3) used in mainstream apps like Strava, can help suit the needs and protections required of users. Zimmer et al. (2018) take this argument further - stating that privacy is in fact the antithesis of QS practices. They claim that "compelling fitness tracker providers to take proactive measures to foster privacy management will likely face resistance, as the nature of the self-tracking industry is to encourage the open flow of personal information" (Zimmer et al., 2018, p. 14).

These are important points to consider. However, it is also important to consider the 'invisible' aspects of digital privacy. While users may wish to share their data with other community members, their information may be available to other parties of whom they are not aware. As self-tracking devices become more mainstream, these issues become more tangled in the web of digital privacy. Consider the potential for data hacking of personal devices or apps, especially those lacking in proper security features. An extreme conclusion might be that "data hacking may harm the user's physical and mental health" (YuXi et al., 2018, p. 3) (However, this assumes that the information captured on the user is integrally tied to their well-being, which may not always be the case).

There are also warnings of the dangers of mixing these applications with corporate interests that have incentives to monetize our "in-app" behaviours. As Zuboff comments in her 2015 article on *Surveillance Capitalism*:

> "Data about the behaviours of bodies, minds, and things take their place in a universal real-time dynamic index of smart objects within an infinite global domain of wired things. This new phenomenon produces the possibility of modifying the behaviours of persons and things for profit and control" (Zuboff, 2015, p. 85).

While this might seem like an extreme position, it raises an important point that users may be providing more information than they bargained for, in the name of self-tracking. Montgomery et al. (2018) concede that the amount of data being collected, combined with weak policies regarding health information management and the regulations that oversee those systems, can lead to increased risks of privacy and discrimination:

> "With consumer health and wellness data continually merged into profiles alongside financial, location, purchase, social data and other information, marketers now possess the ability to track and reach individuals anytime and anywhere, with data-driven marketing technologies that create 'actionable' insights for influencing a person's behavior" (Montgomery et al., 2018, p. 50).

One could ask, does the Nike Running App help people run better? Or is it a slick interface and behaviour tracker with the purpose of selling shoes? Or a trade-off between these various functions? As the authors conclude, there needs to be far more consideration into the design of digital technologies within the "culture of health". Policies worldwide need to adjust to how quickly the field is progressing. As well, consumers need to be aware of the potentially negative implications of engaging with these devices and tools. In the next section, I consider these processes of technology adoption, with the aim of learning what research has found about the ways people take up and use these emerging technologies.

6. Technology Adoption

In this section, I turn to considerations of the adoption of these technologies. As introduced earlier, the Technology Adoption Model (TAM) provides a useful theoretical framework that considers usefulness and ease of use as key factors in whether a user engages with a new technology; in our case, a fitness app, device or smart wearable. Part of this usefulness comes from how the app is designed, through design features such as companionship, social networking, and messaging. Self-Determination Theory (SDT), which as described earlier, provides complementary insights in relation to Intrinsic and Extrinsic forms of motivation. These theoretical frameworks provide useful ways to think about how people adopt new technologies, including mobile digital technologies associated with the QS movement. We can combine insights from TAM with those drawn from Self-Determination Theory (SDT) as a way to understand what encourages change and motivation among mobile app fitness users.

There is a landscape of evolving technologies that consider TAM, MTM and SDT. New devices, sensors and mobile applications all work together to present users with an easy, useful method or tool that addresses their unique personal and social motivations to help them bring about meaningful change in their lives. The success of an app or device depends on a range of factors. Most importantly, the design of an app or device integrates these models and theories. Arguably, the stronger the web of interconnected devices, sensors, programs and user experience (UX) design, the more likely technology is adopted into everyday use, further resulting in the desired behaviour change. However, this process is influenced by a number of barriers, which is the focus of the next section of my literature review.

7. Barriers to Technology Adoption

This discussion of Barriers to Technology Adoption helps provide context to why and how users face opposition when introduced to a new tracking app or device. Limitations are embedded in the kinds of technologies that are developed with personal informatics in mind, including how these technologies are adopted and used. While the QS community is acknowledged to include users whom engage in long-term extraction of large data sets that must be maintained to reach personal goals, basic mainstream self-tracking typically sees "individuals using a new technology in a rather limited and less enthusiastic manner" (Didžiokaitė et al., 2018, p. 1484). Self-tracking for these "average" individuals does not necessarily lead to grandiose changes in their life, but rather very specific "incremental changes" such as walking a few more steps or eating a few less calories.

One reason for these small, incremental changes that result from average use is "cognitive overload". Cognitive overload refers to the level of mental effort required to handle and interpret any and all data collected in order to complete personal goals and tasks. Often discussed under the theme of self efficacy (defined as the belief that a person has in their ability to complete a task), research on this concept generally concludes that with respect to achieving goals, the more tailored a device is to personal use, the better (Brinson, 2018). We could argue that the self efficacy is tied to how much information a person has or needs to complete a task. As pointed out above, research indicates that too much information may hinder self efficacy.

A key goal of Behavioural Design is presenting users with the right amount of information they need in order to bring about behavioural change. Consider the role that information plays when you set personal fitness or health goals. Instead of saying, "I want to lose 50 pounds," which could be considered a large abstract goal, it is more effective to say, "I'm

going to walk every day, starting at just 10 minutes a day." This shift in the type of information used to achieve one's goals is what some refer to as implementing systems over goals. As a habit is formed over time, incremental progress is made that accomplishes the desire task, such as losing weight. In the context of app design, providing too much information can be seen as similar to giving users unrealistic goals that inhibit behaviour change. According to the research, a better approach would be to encourage small, achievable changes, or smaller goals that are linked together as part of a larger system. Therefore, a well-designed app will make suggestions, such as a 10-minute walk, based on data it has collected and interpreted through algorithms that plan out future activity. An app's ability to understand the personal goals of users, and then translate that understanding into incremental behavioural change cues, is an important factor when determining how effective it may be. In other words, according to Behavioural Design research, the more personal the app can track one's goals the more effective it is, and the more cognitive load that is shifted to the computer system rather than the user, the better. Similarly, the more cognitive load placed on the user, the less enthused they may be to continue using the app.

These design and use limitations provide some reasons why some users abandon QS devices. There are many anecdotes available that surmise why people give up on their fitness trackers. Often, after a few months of use, some users report less usage, less attention to tracking details or sometimes complete abandonment of a fitness device or app. In other users, some even abandon a device or app after the successful acquisition of a skill (Attig et al., 2020). Other abandonment reasons involve devices that are too simplistic in their measurement and tracking to provide users with any real meaningful data (Boulard-Masson et al. 2018). An example of this would be simple step-counting features. Boulard-Masson et al. do suggest that single-use devices

could be useful in acute applications in medical practices, such as physical therapy. However, a study from Allouch & van Velsen points to the lack of adoption by physiotherapists who do not use any data from their clients' QS technologies (Allouch & van Velsen, 2018). That is not to say that QS technologies are not being considered by health professionals. More often, it is a matter of lack of access to the data on a standardized level. Another barrier is found in the sociodemographic characteristics of users. One observation is that "digital health self-trackers are mainly young, highly educated, and wealthy individuals whose main motivation for use of connected technologies is to monitor or quantify their fitness behaviors or progress on fitness goals" (Paré et al., 2018, p. 12). This is a matter of accessibility. Mobile apps may hold huge potential for personalized healthcare and fitness lifestyle adoption, but only to those who can afford it.

In some cases, such as in the context of aging, an argument can be made for an increase of reliance on the "authority of data" as it relates to cultural health ideals (Katz & Marshall, 2018). Some apps rely on a cultural consensus that a person should be able to perform certain physical movements and have a certain heart rate based on their age, gender and weight. For example, in Nike's Training Club app, benchmark tests are conducted, and your results are compared to other users within the same gender and age parameters. A message might read, "Your performance was above average for men of similar age." Sometimes these ideals are defined by health associations and professionals, sometimes not. This idea of cultural health ideals can be represented by the kind of data that is captured by new fitness-tracking technologies, especially in the context of the QS movement and the idea of becoming a better version of yourself through data capturing and data interpretation. For example, in a 2018 *Wired Magazine* article the author points to those with diseases or chronic health problems as the

strongest users, saying "tracking and measuring – the quantified self – is what keeps them out of the hospital" (Herz, 2018). A consideration, therefore, should made for the difference of motivation for self-tracking, between those that are simply interested in the tracking for the sake of tracking, those who do so for reasons of efficiency or general life improvement, and those who are required to do so in order to live.

However, if a cultural health ideal is decided by the designers and developers of tracking apps and devices, rather than by health professionals, we can also consider Nim's suggestion that self-tracking is going beyond the individual experience, transforming culture into a 'sensor society' (Nim, 2019). In other words, tracking goes beyond the individual to become part of a shared lived and social experience, where sensors permeate other aspects beyond the physical. This raises familiar issues of privacy and the ethical sharing of information as well as questions of who owns the data captured by the sensors. From that foundation we can begin to ask questions regarding what kind of behaviours are being encouraged by QS technologies, as well as how and why? Though, before moving on, this literature review will turn to instances of when technologies fail to deliver on their premise.

8. Failure: Discontinued Use of an App

It is important to consider possible factors that lead to failure, or rather, discontinued use of a device or app, or failure in an app's ability to help a user implement long-term behaviour change. A study on the *Analysis of Health Consumers' Behaviour Using Self-Trackers for Activity, Sleep, and Diet* clarifies that compliance and use of devices increases the more automated the data collection becomes. However, until data is automatically collected without user intervention, accuracy and reliability of data rests on a user's attitude and behaviour (Kim, 2014). Herz's 2018 *Wired Magazine* article shows concerns with market saturation and that there

is a lack of innovation for truly helpful self-tracking products (Herz, 2018). This is a common thread amongst the literature that points to a problem of a "one-size-fits-all" approach when it comes to tracking design.

To help with long-term engagement, some have considered the idea of financial compensation for users and the tricky balance of immediate payoffs vs long-term benefits. An article in the *Globe & Mail* evaluated these techniques used in the now defunct Carrot App, which gave points to users for physical activity, such as steps taken in a day, that were redeemable at restaurants and shops that partnered with the app. Though studies have shown financial rewards work to "jump-start" exercise habits, as the author puts it, there is also a sobering expectation of "eventual loss of interest that leads people to abandon most fitness apps after six to 12 months" (Hutchinson, 2020).

One alternative reason for this abandonment, however, might not be simply a loss of interest or a lack of engagement, but entirely the opposite. In their study of 133 users and how activity trackers shaped their daily practices of exercising, Karapanos et al. observed a phenomenon called "scaffolding" whereby a user initially found an increased sense of accomplishment, and then a decreased reliance on the tool. "While [the devices] may support overcoming initial motivational problems, they become obsolete, the moment an appropriate practice is established" (Karapanos et al., 2016, p. 8). In other words, users would eventually question why they needed to continue using a device if they have acquired, or perhaps mastered, the skills and behaviours it was designed to teach and implement.

Another possibility for abandonment could be a far more holistic reason, as pointed out by Wu et al. in their criticisms of the QS movement. These included observations of users joining the QS movement unknowingly, discrepancies with expectations of other users within a

social group and more importantly, because of external monitoring of personal health metrics, a reduction in the sensitivity of the body's natural feedback (Wu et al., 2016). A user might therefore ask, why use these devices if they accomplish the opposite of their intended use – that is, encouraging me to become less in-tune with my body?

Perhaps author Nir Eyal, an expert in habit-forming technology, is correct in his approach to why behaviour change apps fail to change behaviours. In a short blog post, Eyal highlights a magical phrase used by successful apps: "but you are free to accept or refuse." Eyal says, "the 'but you are free' technique demonstrates how we are more likely to be persuaded when our ability to choose is reaffirmed" (Eyal, 2013). As we've seen by other examples and studies highlighting design, engagement and locking users into long-term use, one of the biggest factors in a successful mobile app is giving users more control and agency over their use, communication, goal-setting, understanding, and application of their collected data. While it is easy to identify the numerous ways apps fail to help people, and perhaps helpful to identify the features of apps that hinder development, it is more helpful to consider research that identifies clear positive outcomes in the forms of successful behaviour changes and motivation, as discussed in the next section.

9. Behaviour Change & Motivation

Moving from the application of more general concepts and theoretical frameworks, such as the Quantified Self movement as well as Technology Adoption, including Barriers to Adoption, we can turn our attention to research on specific applications on mobile cell phones such as iPhones, Android-based phones, as well as other fitness tracking devices such as GPS watches, pedometers, heart-rate monitors, and other technologies. Again, while self-tracking has a long history, mobile devices that connect to the Internet have acted as a catalyst for the growth

of the movement. Packed not just with tracking tools, but also sensors, data storage, these technologies can automate the tracking of a myriad of data points from a user. These sensors are paired with programs designed to help users interpret the data they are collecting. Often these programs, or apps, are intentionally designed to help users bring about a desired change in their lifestyle or meet their desired goals (See Figure 1).

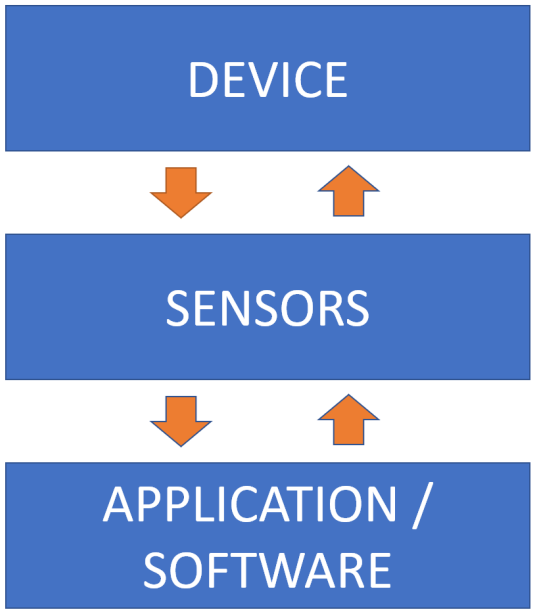

Figure 1. Layers of Behaviour Change Technology

We can fit this under the banner of *Behaviour Change & Motivation*, a common theme amongst the literature in which the ability for mobile apps to encourage behaviour changes or provide motivation to users is studied. One of the clearest observations of the QS movement is the importance not just of collecting data about one's life, but also the need to collect *accurate* data. The QS movement has garnered more mainstream appeal thanks to the fast-paced technological advancement of our digital devices that has given users the ability to accurately track personal traits with little to no intervention, with the caveat that no technology is perfect.

For example, Nike's efforts to bring run tracking to the masses was done with the understanding that though the technology leaves room for improvement, it was accurate *enough* for the average runner or non-athlete (McClusky, 2009).

Despite the technology being "good enough", intervention is still needed to help users interpret and bring meaning to their data. Asimakopoulos et al. (2017) understood this, making the connection between design implications and motivation and self-efficacy. They concluded from their study that the accuracy of the device or app must be in tandem with the presentation of the data and goals for a user to have success (Asimakopoulos et al., 2017). How to use and present this data is an important factor in keeping a user engaged and motivated.

One way to maximize engagement is with evidence-based mHealth intervention designs. (Mitchell et al., 2020). If an app is intended to help a user with their health, it is better to connect with users through proven methods of medical intervention. Pairing developers with health care professionals is one appropriate way to ensure effective engagement (Maher et al., 2014). In that sense, it might be helpful to consider a fitness app as a 'perceived companion', like a fitness coach, physio therapist, or medical professional, where increased importance is placed upon the communication that takes place between a user, a fitness professional, and a QS tool, with special attention made to context and rhetoric. App developers should be asking whether messaging encourages a user to take the information and digital coaching seriously enough to act upon (Jang & Kim, 2020). This concept of the 'perceived companion' is important in its relevancy to how users interact with a device in order to accomplish their goals.

Another consideration of maximizing engagement is considering the app in the context of social networks. In instances of successful behaviour change, social context and friendly competition aid in bringing about behaviour change (Maher et al., 2014). In a study of external

factors for motivations, Li et al. concluded that, “social ranking should be an important design element for fitness-tracking apps, even more important than the objective measurement of physical activity.” (Li et al., 2019, p. 13). Others assert the importance of SDT and individual usage motives, including an affinity for technology interaction, geekism (a deep and unique interest in a subject), and need for cognition (a need to thoroughly understand the uses and applications of the technology) (Attig et al., 2018). While some users may like comparing themselves to others on leaderboards, other users may find an app or device engaging simply because they *like* to engage with or its design feeds into their intrinsic motivations. These kinds of design features contribute greatly to a user’s continued used of an app, which I discuss in the next section.

10. Design

In this section I discuss I discuss how design is a major factor in making fitness apps effective in bringing about change. In this context design refers not just to visual stimuli and appearance, connections and accuracy, but also how an app communicates to users. Gabbiadini & Greitemeyer explain that “media messages are built on the premise that behaviour follows attitude and attitude can be influenced with the right message delivered in the right way” (Gabbiadini & Greitemeyer, 2019, p. 4). One application of this is through perceived behaviour control, which is identified by Gabbiadini & Greitemeyer (2019) as one of the main factors that influence behaviour. According to the Theory of Planned Behaviour (TPM), a successful user believes they can control their goals and progress towards their goals, resulting in positive change. The efficacy of perceived behavioural control is supported by a longitudinal study on the benefits of self-tracking technologies conducted by Stiglbauer et al (2019). When addressing the symbolic function of devices, the authors said that wearing a device becomes part of a person’s

identity and "forces" them to use it to "maintain self-congruence" (Stiglbauer et al., 2019, p. 132). They found that the more behaviour change techniques and theories present in the design of apps, the more effective the app. This includes goal-visualization, comparison to general standards and the combination of devices and data interpreting applications (Stiglbauer et al., 2019). Huang & Zhou (2019) found similar effective techniques in their research of the Chinese health and fitness mobile app market, where they found successful apps using observational learning, such as engaging visual instruction, self-regulation, personalized goal-setting, and social comparison and support, such as fitness benchmarks, leaderboards, or viewing your accomplishments against friends' performances (Huang & Zhou, 2019). Arguably the most effective behavioural change techniques are those that provide "feedback on behaviour" in some shape or form such as alerts when goals are completed are even when there are "discrepancies between current behaviours and goals" (Dunn & Robertson-Wilson, 2018). One interesting way through which feedback is provided to a user is through gamification, which I will discuss in the next section.

11. Gamification

Gamification provides another way to frame how apps draw users into the app and maintain lasting engagement. Though this could fall under the theme of behaviour change techniques, Gamification is a defined area of study. Leading research identifies it as a main pillar of effective motivation technology, so long as its integrated well with other features such as social networking and QS data-collection features (Hamari et al., 2018) In another study called "*Working out for Likes*", Hamari found that apps can strengthen certain behavioural norms through social networks and the ability for a technology to facilitate the creation and strengthening of a community where norms are centered around certain behaviours, such as

physical activity, can produce effective results (Hamari & Koivisto, 2015), a theme that is also found in studies of social comparison. Gamification can also sidetrack users from their preferred goals. Spillers and Asimakopoulos suggest that full-on rewards for activity are not conducive for achieving well-being goals. They say, "Gamification in healthcare and well-being must be carefully designed with minimal 'achievement' and more learning, encouragement and enrichment from the experience and progressively receive feedback about their biometrics as reward, and not to just reward users" (Spillers & Asimakopoulos, 2012, p. 5).

While gamification is a helpful design feature that often does encourage use and short-term engagement, perhaps what is most central to my Capstone research in this discussion is how well an app communicates its messaging in conjunction with how easy the app is to use, in accordance to a user's preferences. I discuss these issues in the next section of my literature review.

12. Communication & Usability

Ultimately, an app's usability can be a deciding factor of long-term engagement. Aitken & Gauntlett conducted an informative study of over 40,000 healthcare apps available in the U.S. Apple App Store, assessing the value they provide to a user. The report claims, "an assessment of the functionality of available apps finds that healthcare apps available today have both limited and simple functionality – the majority do little more than provide information" (Aitken & Gauntlett, 2013, p. 2). The authors also consider the wariness of physicians to formally recommend apps because of a lack of scientific rigor – a common concern among other studies. For example, in an older study from 2010, as QS interests began increasing, Albinali et al. consider new technologies that provided novel ways of measuring energy expenditure. Their conclusion points to the need for an accurate profile of a user in order for a device to be correctly

calibrated and useful (Albinali et al., 2010). This is to say that general presentation of information is not enough – there needs to be a personalized approach. Furthermore, in a study that looked at the continued use of health apps, as opposed to the common approach of looking at initial adoption, Cho found that "Contradicting initial expectations, perceived usefulness did not have a statistically significant effect on health app satisfaction, although perceived ease of use was positively and significantly associated with user satisfaction" (Cho, 2016, p. 81). The best way for an app to encourage users to continue using it is how easy it is to use, and not necessarily how relevant or important its information is – a finding supported by the Technology Adoption Model. This is supported by Middelweerd et al., who concede that "the inclusion of established behaviour change techniques is far from optimal in most apps." (Middelweerd et al., 2014, p. 7). This is assuming that BCTs are an effective method of making apps easy to use versus simple information presentation. Liu et al. considered this in acute study of the use of text reminders in fitness apps. They found that these kinds of reminders re-enforced behaviours of self-monitoring and adherence to personal goals (Liu et al., 2018). Importantly, text-reminders cannot be arbitrary. To be successful they need to be context-aware to move users toward certain behaviours. This supports observations that how information is being presented and how easy it is to move a user towards action determines its effectiveness.

Furthermore, it is also important to consider the characteristics of the device itself. In their study, *"Making Lifelogging Usable: Design Guidelines for Activity Trackers",* Meyer et al. found that a third of participants "considered smartphone apps not to be as practical as dedicated activity tracking devices because they would not wear a smartphone continuously and close enough to the body which resulted in incorrect and incomplete data" (Meyer et al., 2015, p. 329). Again, we find support against a one-size-fits-all approach. If a device cannot seamlessly

integrate with lifestyle in order to capture relevant data without interfering, what good is the device if it becomes an irritant or is only able to capture incoherent and incomplete data? Part of that lifestyle integration is the way users can compare themselves to their peers or competitors, which is discussed in the next section.

13. Social Comparison

In this section I look at one of the key characteristics of successful app use to bring about change – Social Comparison. While it may be idealistic to think of the social aspects of fitness apps in terms of connection and sharing, studies addressing the social components of fitness mobiles apps and tracking devices have observed a more significant phenomenon in social comparison. In their study of *Exploring Social Incentives for Mobile Fitness Applications*, Chen et al. found that by combining competition and cooperation, physical activity completed with others was 15.1% higher than those who performed alone. However, this significance was only apparent in hybrid settings, and not solely competitive settings (Chen et al., 2016). While Chen et al.'s study considered cooperation, Mollee et al. focused their attention on upward and downward social comparison, while also advocating for careful design of interventions that use social comparison (Mollee et al., 2016). They found that users prefer to look upward at those doing better in performance as motivation to increase physical activity. Similar conclusions came from Zhang et al. with a leaning toward comparison over cooperation. They found that "social comparison in online networks provided a significantly greater source of social incentives for increasing physical activity than social support" (Zhang et al., 2016, Pg. 5).

While Arigo et al. also observed that social networking and comparison were ways to facilitate online physical activity, with the help of automated self-monitoring, their study of women's use of social features showed a preference for increased communication but more

importantly that direct comparison or competition resulted in negative responses (Arigo et al., 2015). Apps cannot simply capture information and relay that back to a user. There must be room for context, community, tailored messaging, custom aggregation, and personalized goals, plans and settings. App and device design should consider the needs of the user, including individual characteristics. Social comparison is an important Behaviour Change Technique to consider. As Shih et al. observe, "physical activity trackers could benefit from this by aggregating information from the user base and allow users to identify and learn patterns from others who share similar personal and situational contexts" (Shih et al., 2015, p. 9-10). In short, understanding how others use a technology can reveal the best path forward for an individual.

14. Conclusion & Next Steps

Overall, given the recency of this field of study on apps and their effectiveness in fitness and physical activity applications, the literature has established good footing upon which we can conduct further research. The Quantified Self coupled with Behaviour Change Techniques provides excellent footing on which to understand the origins and over-arching goals of the field. However, critical issues of privacy, effective design and sociability are clear obstacles that users must navigate. Tracking technologies bring with them issues of an increasingly complicated environment, specifically concerning data ownership, data access and increased personalization and identification. As well, the sharing of information among communities and industries increases concerns between the benefits and trade offs of using mobile applications and tracking devices to intervene on physical activity participation.

As determined in my review of existing research, a user may become well suited for meeting the encouraged behaviours within an application, due to successfully implemented design techniques, communication and features. However, there remains a question of whether

these users are able to translate, pivot and apply these skills and physical aptitudes in other real-world, external settings. Put differently, does QS application use translate into 'offline' activities, and if so, how? This brings us back to my research question on whether mobile fitness applications and tracking devices aid in the development of real-world physical skills. A longitudinal, experimental research design employing standardized external testing at regular intervals of a population of mobile fitness app users would be required to answer this question. However, my research can help explore this issue through conducting interviews with users of a QS-themed platform about their own experience and perceptions of the application and how they use it in their daily lives. In the next chapter, I turn to my research design, which focuses on a consideration of the real-world results and aptitudes of fitness app and device users. I describe my research design and establish my plan to conduct qualitative interviews of app users and their results from external physical fitness testing through *The Strenuous Life* platform.

CHAPTER 3: Research Design & Methodology

15. Site of Analysis: The Strenuous Life

"I wish to preach, not the doctrine of ignoble ease, but the doctrine of the strenuous life." – Theodore Roosevelt.

In this chapter I introduce the context of my research, and specifically my site of analysis. This is followed by an examination of qualitative analysis, my choice of semi-structured interviews, descriptions of the participants and their recruitment followed by an overview of my data collection and analysis.

To help understand the concepts discussed in my review of the literature in a real-world setting, my research looks at the experiences of users of the online platform, *The Strenuous Life*,

(TSL). Found at http://strenuouslife.co, TSL is a social media-like website that encourages behaviour change and skills development. Members are required to pay $200 USD upon entry – a purposeful behavioural design feature that facilitates users to "put skin in the game" – a financial incentive to participate honestly in the platform's activities (as well as generate revenue for the site developers and administrators). As noted by some members, cheating in TSL only results in you cheating yourself.

Members of TSL are presented with multiple ways to develop physical and mental skills. First, there are weekly challenges, called "Agons", emailed to a member every Saturday morning. Each week, a new Agon is presented with certain parameters and the member has the week to complete it. For example, Agon 6 says, "Do as many push-ups as you can in a single set as soon as you get out of bed each morning." If the standards are met, the user can mark the challenge as complete on their profile. TSL also provides forums in which users can interact and communicate with other users and discuss the Agons and their parameters, similar to other social media sites or social features and areas found on fitness apps.

In addition to the weekly Agons, users are also required to fulfill two daily requirements. Requirement one is to perform 60 minutes of physical fitness – anything from a brisk walk to a full barbell workout (see Figure 2). Requirement two is performing one good deed. A good deed can be considered anything that benefits another person or community, such as a sincere compliment, donating food, or shoveling snow off a neighbour's driveway.

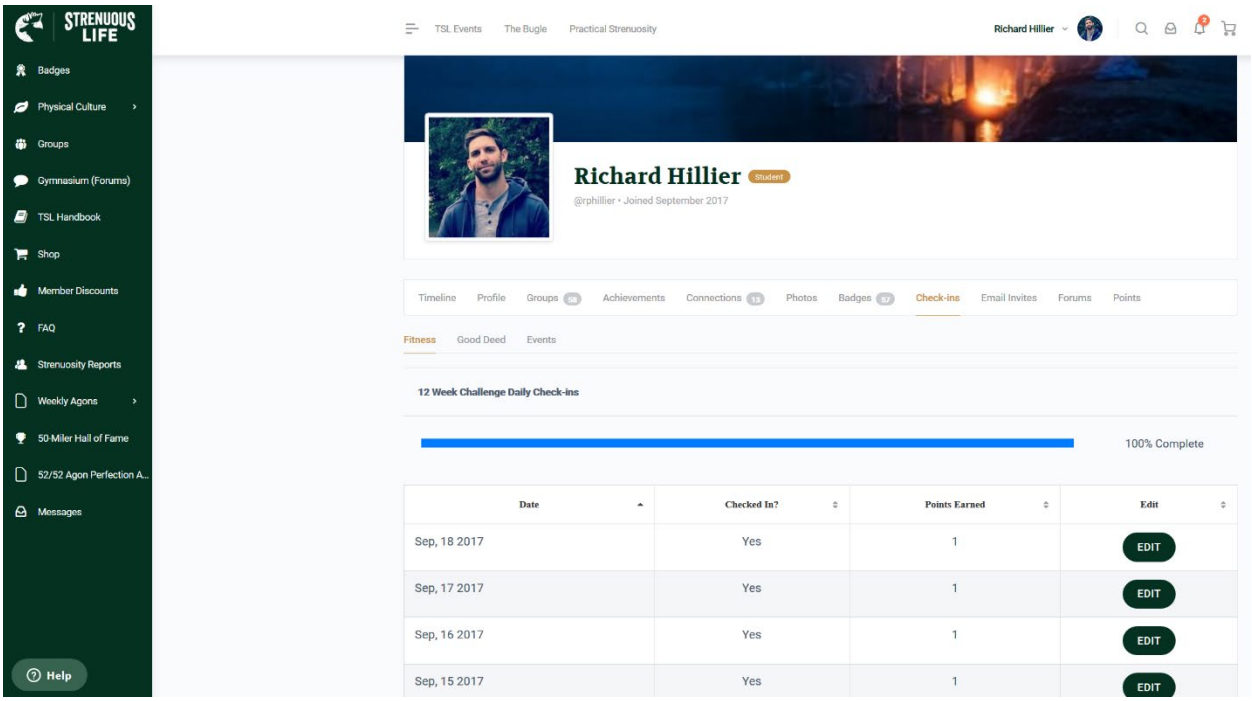

Figure 2: Example of Daily Fitness Requirement Checks within a User Profile on The Strenuous Life

There are also over 50 "Badges" – hard and soft skills – each with multiple requirements that must be fulfilled before the badge is awarded (see Figure 3). The "Frogman Badge", for example, requires a member to swim certain distances, the "Firemanship Badge" requires skills to safely build fires through different methods, and the "Biographer Badge" requires members to read a number of biographies and write a paper review of each. Some badges have time constraints, but most can be completed over weeks, months, and years.

Some weekly Agons and Badges require not just time spent performing physical tasks, but also improving those physical skills. For example, four times a year, an Agon called the "Army Ground Forces Test" is sent to members, comprised of physical skills such as pull-ups, push-ups, sit-ups squats and sprints. To complete the challenge, members are required to improve upon their scores with each subsequent test by one repetition. A failure to increase your

rep by one results in a failure of the Agon. Similarly, the “Barbell Badge” requires a certain weight to be lifted, relative to bodyweight, such as deadlifting 1.7x a user’s bodyweight.

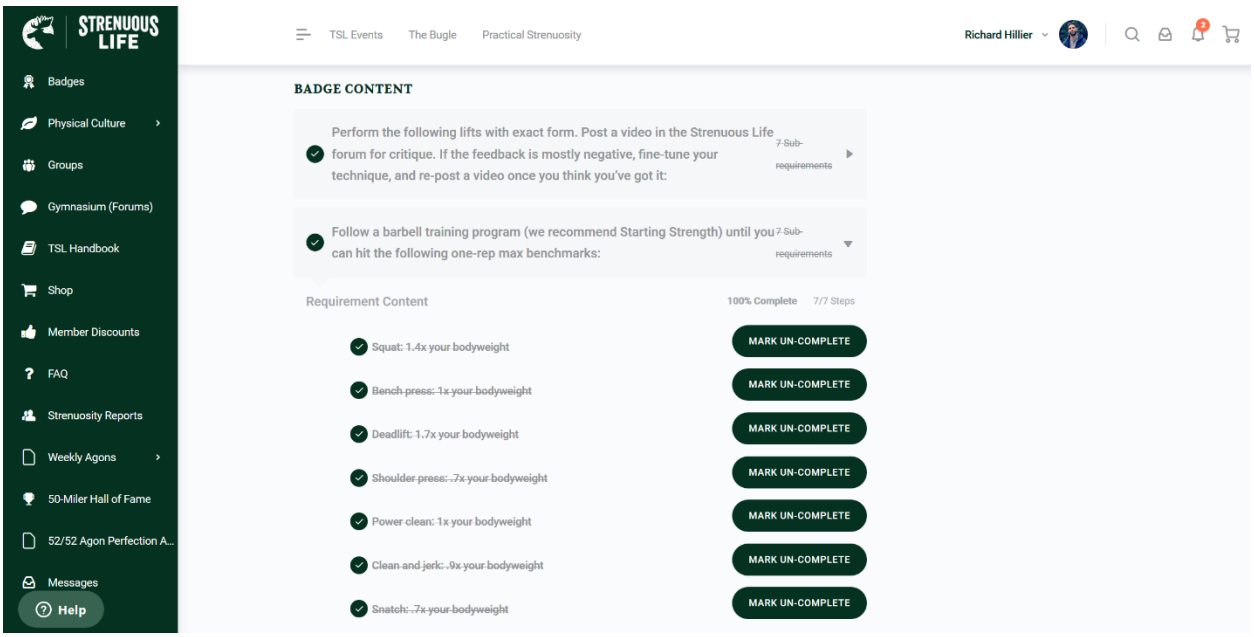

Figure 3: An example of the Barbell Badge requirements on The Strenuous Life

Through encouraging members to complete these various activities and track their progress, TSL provides an example of a community in which we see echoes of the Quantified Self, where personal tracking is closely tied to one’s personal values. The platform has strongly implemented behavioural design techniques that draw members towards a collection of shared values: “As we seek to become more fit, skilled, temperate, frugal, patient, courageous, resolute, and honesty, we strengthen and improve our families, communities and country” (The Strenuous Life, 2018). The TSL platform asks all members to adhere to certain morals and values to help drive their participation. As mentioned, a major component of behavioural design are social features that encourage social comparison, competition, and ways to encourage peers. TSL builds accountability into the program by requiring members to upload photos, or “evidence” of them completing at least one requirement for a badge. Certain forums on the site also include

leaderboards that compare users' completion of tasks. However, most of the skills acquisition and requirement completion is done using the "honour system" – it is up to the member to decide for themselves whether they have correctly performed to the standard. In addition, TSL facilitates in-person meet ups to help members work and improve their abilities together.

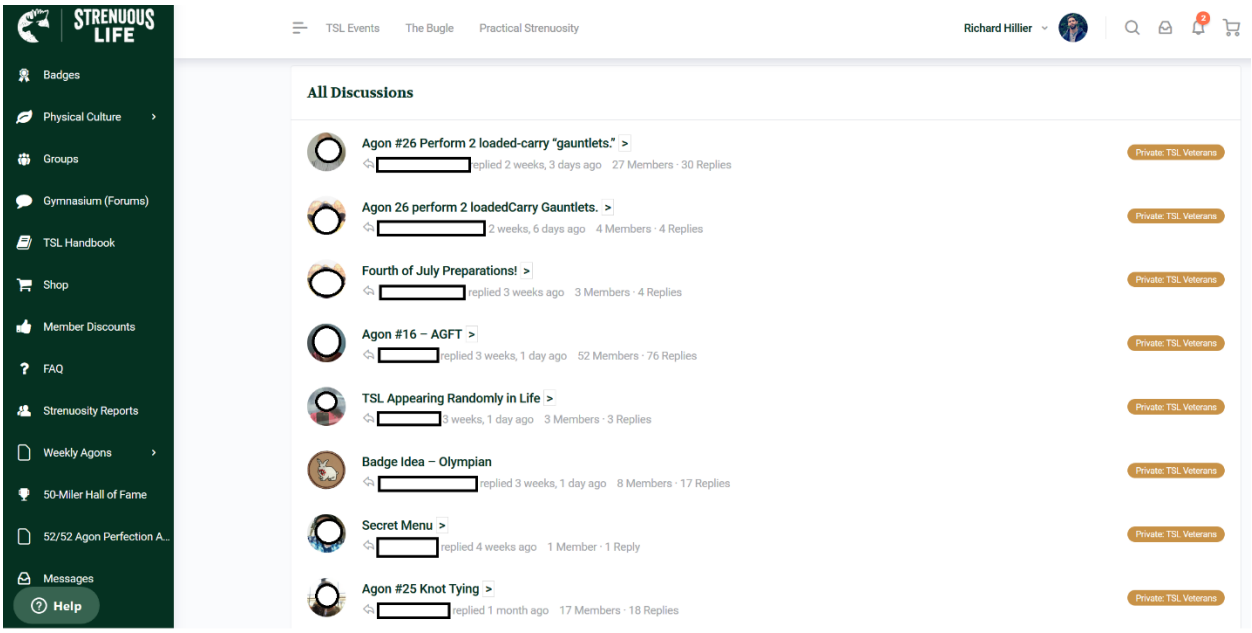

Figure 4: An example of the Veteran's Forum. Member names and images have been blocked out.

Although the TSL platform covers a range of skills, this research will focus on the physical fitness activities presented on the platform. According to the website, "Physical fitness plays an integral role in The Strenuous Life. Development of the body serves as a foundation for the development of one's mental and spiritual capacities… In short, we become strong to be useful" (The Strenuous Life, 2018). I chose to focus on these physical activities because all members of TSL must incorporate daily fitness into their regular routines, and many of the weekly challenges are physically based, trackable and easily measured, as opposed to more abstract skills such as reading comprehension, or social-based skills. One important factor of the program is that when it comes to physical fitness, TSL doesn't feature any integral automated

tracking system, other than the completion of requirements, which are manually checked off by users. Rather, it provides ways to digitally log progress and also view any other user's progress. Any tracking of physical activity must be done externally, and that information can then be shared with the TSL community per each user's discretion (see Figure 4).

For this research, I interview active members of the TSL community about what fitness apps they use that aid them in the completion of the weekly challenges or badges issued by TSL. These activities are focused on physical skills development and fitness. Whether it is increasing the amount of weight lifted with a barbell, how far they swim, or how fast they run, TSL users provide insight to help determine whether fitness apps are helpful in developing their physical fitness skills, as positively indicated by successful completion of badges and weekly challenges.

16. Qualitative Analysis

In this section I provide an overview of my choice for Qualitative Analysis of my research data. As discussed above, this study is designed to gain insight and understanding about the acquisition and learning of skills using smartphones and digital devices. The literature review identified themes that are most applicable to this research, including: The Quantified Self, Technology Adoption, Behaviour Change & Motivation and Communication & Usability. These themes helped shape my research question, which seeks to answer how mobile fitness applications and fitness tracking devices aid their users in the development of real-world physical skills. Furthermore, the research is designed to also answer questions of how and why apps and devices are successful or not in helping users acquire desired skills.

The best way to approach this research is through a qualitative analysis. Much of the current research into behavioural design of health related apps has used quantitative and survey-

based approaches to determine the "what", such as the behaviours exhibited by users, successful tracking and achieving of goals and general use-cases of a specific smartphone applications or devices and their effectiveness. Though, some studies, such as that from Zimmer et al. (2018) combined surveys with semi-structured follow-up interviews to find a more complete picture of how someone used a device or app.

Although the design of the TSL platform provides rigid requirements for skills acquisition, the path to get there is open-ended and requires a member to be resourceful in their approach to self-education, skills-practice and accountability. Therefore, a survey or questionnaire, as is typical to see in a study of QS and behavioural design, would be inadequate in understanding the motivations and methods used by TSL members. Furthermore, though the TSL program does incorporate instances of QS techniques and methodologies, they are not inherently built into the platform, other than a high-level measurement of task completion. For example, members are required to complete check-ins, completing 60 minutes of physical fitness activity and one good deed as defined by the program, each day. At most, this is a binary check – a yes or no. There is no tracking of the fitness requirements such as level of effort or exertion, amount of distance covered, amount of weight lifted, etc. Similarly, a fitness-centric badge such as the barbell badge and its numerous requirements, simply asks a member to lift a certain weight, relative to body weight, using a specific technique. (e.g. 1.7x bodyweight with the deadlift). Again, this is a binary check – a yes or no of having completed the task. Other than a blank digital "log-book" in which a member can record their daily fitness activities, the TSL program does not implement any automatic logging or experiential data collection or extrapolation of fitness activities.

TSL members are therefore encouraged, both implicitly and explicitly, by program documents or other members, to use external resources and tools to help them achieve the badge and fitness requirements. Some of the suggested tools are online fitness programs where the extent of the logging, in the form of traditional QS techniques, is nothing more than a pen and pad of paper, where weight, sets, reps and time are recorded each session. However, depending on the badge, weekly Agon, or daily fitness goal, a number of users choose to implement mobile fitness applications and tracking devices to capture their fitness data and help them implement changes in order to achieve both personal fitness goals, as well as meet the various TSL requirements. For these reasons, this research uses semi-structured interviews to capture the experiences and explanations of TSL members. Interviews explore their choice and use of their chosen apps and devices, which they believe best equips them to meet their goals and the TSL requirements. A qualitative approach is best suited for capturing this data as well as coding and interpreting the results.

Initially I considered conducting focus groups. One interesting characteristic of the TSL platform is that it automatically organizes its members into groups, or "Classes" upon enrollment, with whom they collectively advance through a "Boot Camp" of special challenges. Members are also enrolled in the Geographic Groups, based on their location, in order to facilitate physical meet ups with their TSL peers in order to complete more TSL requirements with other members in person. As members progress through the weekly challenges, they are eventually graduated into other online groups, such as the "Veterans" Group, reserved for members who have committed to the program for an extended length of time, but also show more enthusiasm in their participation, accountability and general pursuit of requirement completion. This is to say that TSL inherently provided rich opportunities to address multiple

groups of members at the same time. However, despite this organization of membership, TSL still remains at its core an individual pursuit with individual nuances and affordances that make for highly individualized experiences. Therefore, I determine that individual interviews are more appropriate for ultimately understanding the approaches a member took to physical fitness with the use of apps and devices. Again, qualitative assessments of the data capture from interviews allow me to go beyond a quantitative approach of whether a goal was achieved, a requirement met, an activity conducted, or a skill acquired, all based on the condition of mobile app and device use. A qualitative approach allows me to go into the experiential interpretation and application of data acquired from apps into the TSL program by its members. Semi-structured interviews provided the best environment in which to conduct this qualitative analysis, as discussed in the next section.

17. Choosing Semi-Structured Interviews

Though much of the current research in QS and behavioural design uses surveys and questionnaires to better understand the phenomenon of user experiences within apps, some studies do use semi-structured interviews to go deeper into understanding the "why." In her book *Mastering the Semi-Structured Interview and Beyond: From Research Design to Analysis and Publication,* Anne Galletta gives a succinct overview of why semi-structured interviews can be helpful:

> "Semi-Structured interviews incorporate both open-ended and more theoretically driven questions, eliciting data grounded in the experience of the participant as well as data guided by existing constructs in the particular discipline within which one is conducting research" (Galletta, 2021, p. 45).

This approach also helps ground the interviews in both Self-Determination Theory and the Technology Adoption Model, while also emphasizing the important of each participant's experience with their digital tools. Furthermore, the semi-structured interviews provide an opportunity to understand the effectiveness of the communication techniques used during the participants' online and digital experiences.

In this research I am trying to understand the experiences of TSL members – how do they use apps to achieve their goals? Establishing a stronger understanding of context and user activity levels prior to joining the TSL program helps with this. Some users may have been familiar with app and device use, others may have been introduced to new digital tools through interactions with other members. Semi-structured interviews, therefore, enable members to express their experiences, conclusions and reasoning without the limitations of a more concise survey or questionnaire. While certain baseline questions help establish consistency among study participants, the interviews also provide opportunities to follow up or expand on relevant issues as they appear. Next, my Capstone provides a description of the participants and the context in which I approached them for my research.

18. Participants

Though this research is looking to answer the general question of how users of mobile apps and tracking devices acquire physical skills, potentially leading to future research of general populations, this study is observing the phenomenon in a specific group of people: Participants for this study were selected from members of the online self-development program, *The Strenuous Life (TSL)* found at http://strenuouslife.co. The platform was selected in order to provide a strong sample of users/participants who consistently use mobile apps and devices to

track physical activities such as running, hiking, swimming and other fitness activities that require general skill and aptitude.

All participants in this research are active members of TSL and will have paid the initial enrollment fee. (This fee is paid directly to TSL administrators and not to the researcher of this study). Participants are also not limited to geographic location. Though purchases are made in USD, there is no geographic requirement outside of the location-dependent geographic forum groups. As described by the FAQ section of TSL's website, reasons for charging members include removing ads, limiting poor online interactions between members, and requiring members to make a monetary commitment, or what TSL refers as "putting skin in the game". In other words, the risk of participation lies on the user.

Participants also completed the first 12 weeks of the TSL program. TSL refers to these 12 weeks as the initiation phase, or Boot Camp. All members must go through the Boot Camp and are awarded upon its completion. The Boot Camp is comprised of three parts: 1. Complete all the requirements of one badge; 2. Complete 12 weekly Agons consecutively; and 3. Complete 75% of the daily physical activity and good deed check-ins. Participants for this study will have successfully fulfilled the Boot Camp requirements of TSL.

The study therefore used a purposeful sample of the TSL membership who also actively use mobile apps and tracking devices as part of their daily fitness routines. The current population of the Veterans groups is just under 1,000 members, with varying degrees of participation. Additional groups are open to every TSL member. Though all members of the Veterans Group, Barbell Group, Frogman Group, and Ontario group were available for recruitment, only participants who responded to the recruitment call were interviewed. A total of

six interviews of members from the Veteran's group were conducted. Since I am also a TSL member, I had easy access to the membership lists of each group. I chose to solely recruit from the Veterans group because of their longstanding commitment to the program as well as their increased willingness to participate in ongoing discussions with other members about their TSL experiences.

I also received consent from the TSL moderators and website owners in order to contact some of the membership about participating in the study, despite the content not being directly related to regular TSL activities. All recruitment and communication with participants adhered to the standards set through my ethics application after receiving ethics approval from the University of Alberta's Research Ethics Board (REB). I conducted the interviews at appropriate and convenient times for the Veteran TSL members who agreed to participate. In the next section I go into more detail regarding the recruitment of my participants.

19. Recruitment

Recruitment for this Capstone project took place in the Veteran's group forum. The reason for that choice was to find a strong selection of participants who could provide meaningful feedback and responses during the interview process. Most members in the Veteran's forum demonstrate a higher interest in sharing their attempts to complete requirements, and routinely hold discussion on what constitutes a correct method of learning, practising and acquiring for a requirement attempt to be counted. One limitation of this study is that responses are restricted to members of the Veteran's group. Another is that TSL operates on the honour system: members are expected to be honest with their completion of the requirements. Therefore, there is no way of independently determining or verifying whether a TSL member (including a

Veteran) has completed the requirements they said they have. The TSL community's culture suggests that if a member were to cheat or lie about their progress, they'd be cheating themselves and the other TSL members; after all, what good is it to say you have acquired a skill on the Internet, if in real life you have gained nothing at all? While I recognize this potential limitation with respect to the characteristics of TSL Veterans, my analysis of the platform indicates that members of TSL and the Veteran's forum uphold a rigorous standard not just for members, but for themselves. Therefore, the Veteran group provides ample opportunity for research into the use of tracking apps and devices that may benefit their progress within TSL.

To recruit participants, I created a new post in the Veteran's forum titled "Participants Needed for Research Study". The body of the text contained the recruitment letter and contact information in order to continue as a participant in the research. Participants were discouraged from responding to the forum post and were directed to the researcher email address provided. As noted in my methodology chapter, I aimed to find 5-8 participants. 6 TSL members reached out to me with interest to participate. After providing a consent form to sign, all 6 participants continued to the interview stage within a week of initial contact, where time and dates for each interview were decided based on participant preference. I conducted all interviews on the Zoom video-conferencing platform. I sent each participant a personal invitation-only link to join me for the interview. Throughout the recruitment process, I followed the ethics procedures outlined in my approved application, and secured consent to participate and record the interview. The full list of semi-structured interview questions can be found in Appendix B. The online tool *otter.ai* helped to transcribe the interviews and the Taguette online tool helped to code each interview. The interviews range from 30-60 mins, as expected.

It should be noted that all the participants are male with an age range between 25 and 50. They are all located within the U.S.A., though they are located across the country, reflecting a diversity geographic range of participants. Not all members share their personal details on the platform, but observations from the interviews identified general age and locations. I made accommodations to address the time difference. Though the TSL platform is open to women, and the veteran's forum includes female members, none responded to the recruitment efforts, despite inclusive language used throughout the recruitment process. This may be due to the majority male population of TSL: an estimated 99% of the TSL community self-identify as male. (No exact percentage is currently available). This gender disparity among participants is an important limitation to note in relation to my findings.

20. Interview Questions

I interviewed study participants using the Zoom Video-Conferencing tool and I designed the interview questions to understand TSL members' experience with the TSL program and platform, and to gain insight into their use of mobile apps and tracking devices during their membership. Specifically, conversations sought to discover reasons for app and device use, as well as how apps and devices were used to gain physical skills that would help members fulfil TSL requirements.

The interview questions address themes identified in previous studies including awareness and participation in Quantified Self tracking activities, whether manual or digital, awareness of behavioural design and its effects and/or perceived influence, discussions around technology adoption, issues of digital privacy, preferences of communication style and message delivery, gamification techniques, and general usability. During the interviews, I provided

clarification as to the purpose of the study, addressing the aim to discover how apps are used to improve fitness and acquire skills, and that TSL provides a unique motivation for such use.

Overall themes for the interview questions included experience with the TSL program, reasons for joining, the physical aspects of TSL, general experience with physical fitness as well as their history and aptitude, experience with mobile apps, experience with tracking devices, the decision making process of integrating apps and devices into their TSL participation, familiarity with the QS movement, awareness of behavioural design, concerns of privacy, attitudes toward communication and usability, personal learning and practise styles, abilities and tendencies, what skills they have acquired or developed since adopting new technology devices, as well as experiences with failure. Attention was also given to the members experience with the quarterly Army Ground Fitness Test administered four times a year by TSL, as well as fitness-based badges such as Barbell, Frogman, Outdoorsman, Rucking, and others. I asked participants a standard set of questions with space for dialogue to explore personal experience and opinions.

Limitations of this research study include a potential bias since I am a member of the TSL program and also use mobile fitness and tracking devices. Though, it is acknowledged that this membership helps in communicating with the population sample. Also, the large majority of participants are male. Though the TSL program is open to any person and does not discriminate, the majority of its demographic are younger males. Thus, the results of this study will reflect a male perspective and experience. Though, females that were part of the Veterans and fitness-based groups were encouraged to participate.

21. Data Collection and Analysis

I recorded the interviews using Zoom and stored the data on a local computer hard drive. I transcribed the recordings using the otter.ai online transcription tool.

Analysis of the interviews began with coding based on the semi-structured questions. I grouped answers together based on the themes of Quantified Self, Technology Adoption, Motivation, Privacy, Communication, Usability, Failure and Behavioural Design. The coding process and findings are further discussed in the findings section below. Data was also collected through the interviews regarding the kinds of devices used by participants, as well as the apps, systems, and tracking techniques used, along with their personal fitness goals, no matter if those aligned with the requirements of *The Strenuous Life.* This is an important clarification. For the benefit of future research, it was necessary to collect data regarding the personal informatics and behaviours of those who were committed to the improvement of their own health, fitness and activity levels. Though, *The Strenuous Life* provided an additional motivation for participants. Analysis of the data required consideration of this extrinsic motivation, even though it came from another digital tool.

After completing the interviews and transcriptions, I conducted an inductive qualitative content analysis informed by literature. When examining the interview texts, I looked for patterns in the form of similarities, differences, frequencies and correspondence (Saldana, 2016). This analysis was considered through the filter of my literature review, comparing these patterns to the themes presented by previous researchers. The first analysis coded the text for general instances of the following categories:

Action, Barriers to Technology Adoption, Behaviour Change, Benefits, Communication & Usability, Design, Devices, Engagement, Failure, Gamification, Improvement, Join, Metrics, Motivation, Personal Values & Goals, Physical Fitness, Privacy and Surveillance, The Quantified Self, Self-Determination Theory, Skills Development, Social Comparison, Technology Adoption, Testing, and Tracking.

A second analysis of these coded categories and the data I coded revealed overall themes through analytic reflection (Saldana, 2016). In analyzing the codes and emergent categories, I referred to the following explanation: "think of a category as a word or phrase describing some segment of your data that is explicit, whereas a theme is a phrase or sentence describing more subtle and tacit processes" (Rossman and Rallis, 2003, as cited in Saldana, 2016). Regarding my data, in many instances the interviews contained explicit mentions of my developed categories, such as specific mentions of tracking or design. In a few instances, participants provided more subtle insights that required analytic interpretation, which resulted in the overall list of emergent themes as described later in my Capstone.

CHAPTER 4: Findings

22. Overview of Findings

Having established the participant characteristics, their recruitment, and their interviews, this next section focuses on the interview results. I highlight the similarities and differences between participants, but more importantly, draw out from the data highlights that help answer my research question of how apps aid users in developing physical skills. This section focuses on the themes which emerged from the interview data, and I present them in relation to findings from the literature review. My data analysis filters the transcribed interviews through those themes in order to ultimately identify how and why participants found self-development success

through the use of mobile apps and tracking devices. My goal in this chapter is to establish how the current literature on behavioural design is still relevant in how understanding the design, functionality and purpose of new technologies, and how the established themes from the literature can be applied to real instances of users incorporating regular app use into their lifestyle, acquire physical fitness skills and achieve desired behavioural changes.

Overall, participants shared a wide range of answers and feedback in response to my questions. While their range of answers will be discussed in terms of how they use apps based on the literature, it was interesting to note that the 5 out of 6 participants stated they regularly used apps as part of their normal fitness routines or general physical activity. Interestingly, one participant highlighted their dislike for physical activity in general and commented on their use of apps to track physical activity as a way to help them reach the goals as outlined by *The Strenuous Life*. This finding shows the significance of extrinsic motivation (Attig et al., 2018). As the participant noted:

> "Basically, it's a lot of external motivation for that kind of thing… I don't really care. I guess it's helpful. But me personally being stronger, faster, or that kind of thing, I don't get a reward in the process and the accomplishment's not special to me beyond the fact there's a badge of marking" (Participant 1).

While it is an outlier in my sample, this finding suggests that for this individual, *The Strenuous Life* platform provided a framework which helped participants discover new tools and methods to acquire skills or develop the skills they already had.

Most participants also showed an affinity towards physical activity, though their reasons for engaging in physical activity greatly differed. This provided evidence of a strong connection

to Self-Determination Theory as well as a connection toward a theme of personal values & goals and their relation to how they engaged with digital tools to bring about behaviour change in their daily lives. Participant 3 frames this key finding well, stating that: “When I started the TSL Program, I wasn’t a fitness guy. Really, starting the program gave me a reason to start getting into fitness and I actually found out that I enjoyed it. And then I started using all of those apps.” (Participant 3). The next section will discuss the emergence of the various themes from the interviews along with a discussion of the coding process and interpretation of the results.

23. Emergent Categories

As discussed, the interviews revealed general instances of the following categories: *Action, Barriers to Technology Adoption, Behaviour Change Techniques, Benefits, Communication & Usability, Design, Devices, Engagement, Failure, Gamification, Improvement, Join, Metrics, Motivation, Personal Values & Goals, Physical Fitness, Privacy and Surveillance, The Quantified Self, Self-Determination Theory, Skills Development, Social Comparison, Technology Adoption, Testing, and Tracking.* For example, in answering a question about what would make them stop using an app versus what keeps them coming back to an app regularly, Participant 4 said, “If it’s frustrating, if you feel like it’s not working, if it’s not reliable, yeah. I mean, whereas if it feels like it’s working well, yeah, you just go back to it.” The instance of the words “frustrating”, “reliable” and “working well” indicated themes of design, use, and barriers to technology that I identified in the literature review.

After this first round of analysis, I grouped the above themes into larger subsets that contain the major ideas that emerged from the interviews. All 6 participants produced examples of all 6 major themes of Technology Adoption & Behaviour Change, App Design & Use, Values

& Goals, Skills Development, Social Comparison, and Tracking.

24. Table of Major Themes

Major Themes	Number of Overall Tagged Codes	Initial Codes Identified in Text	Example Quote from Interviews
1. Technology Adoption & Behaviour Change	112	Action, Barriers to Technology Adoption, Technology Adoption, Failure, Behaviour Change, Join	"I you know worked out but if you're gonna be doing strength training you need to have a program, whether it be an app or even just a spreadsheet, right, and you need to be tracking those." - Participant 4
2. App Design & Use	107	Communication & Usability, Design, Devices, Engagement, Gamification, Privacy & Surveillance	"I would say that the kind of the quality and the way things are set up is directly related to whether or not I'm going to use it, you know, again, and again, right? So, if it's bad, I'll probably use it like once or twice. And I'm like, I'm done. I'm never gonna use this thing again." – Participant 6
3. Values & Goals	96	Benefits, Motivation, Personal Values & Goals, Self-Determination Theory	"Being stronger, faster, or that kind of thing I don't get like a reward in the process and the accomplishment's not special to me beyond the fact there's a badge of marking." – Participant 1
4. Skills Development	88	Improvement, Physical Fitness, Skills Development	"For creating a framework of how do you know if you know something or not? Do I know enough? Do I know enough about this thing or that thing?" – Participant 1
5. Social Comparison	30	Social Comparison	"You see the postings from people and your, your class, it's like, Okay,

			well, I did my 10-minute walks and I did a 20-minute walk and then, okay, so that's tactically exercise." – Participant 5
6. Tracking	113	Testing, Tracking, Metrics, The Quantified Self	"Yeah, for the strong lift [app], the whole idea is that you're tracking your numbers. So, you don't have to, I guess, write them down and track them yourself. So, it's useful just in that regard to see, what did I do last time?" – Participant 3

25. Discussion of Findings

In this section I discuss each major coded theme in further detail, connecting these emergent themes back to the findings of my literature review. This discussion also provides examples from the participant interviews that show how these themes emerged. My analysis demonstrates how much of the current research into app use for self-development purposes is still applicable even as new technologies emerge, or new platforms for digital interaction develop.

1. Technology Adoption & Behaviour Change

Technology Adoption, as well as barriers to adoption, includes instances of when an app was installed and regularly used by a participant, as well as when an app was examined but ultimately rejected. While Behaviour Change could be considered a part of App Design & Use, I decided that users successfully adopt certain apps because they believe those apps help bring about successful behaviour change.

Across all interviews there I found 31 instances related specifically to Technology Adoption & Behaviour Change. I initially established reasons for joining the TSL platform to ground later explanations for using specifics apps or tools for tracking purposes. In all the

interviews, participants identified the attraction of the TSL platform and what the program offered to them in relation to their desires to change their behaviour, both physically and intellectually. Early on in each interview, participants acknowledged their use of apps as an expected behaviour in order to track their metrics for physical activities and ultimately complete certain physical fitness requirements within TSL. Though the program and its resources are primarily digital, it also offers analog versions of its materials. One of the participants expressed a preference for the hardcopy TSL badge book to track their progress on requirements completed, versus using the website, though they acknowledged they would still go on the website occasionally to officially check off a requirement.

Overall, one of the most expressed features that participants wish they could use for tracking would be a device that is able to capture the highest amount of data and be versatile enough to be used with a high number of activities and that could potentially connect with a high number of other devices and tools. Ultimately, participants expressed interest in apps and devices that tracked their most important metrics and that could accomplish the task of completing a high number of TSL requirements alongside their general day-to-day workouts.

The adoption of a new technology is often influenced by the ability of users to see historic progress and plan out the next steps of a goal or physical challenge. In this study, this is seen for example in completing another round of TSL's Army Ground Forces Test, which expects you to improve your scores with each attempt. Referring to their Apple Watch fitness and tracking device, one participant commented that, "Without this [the Apple Watch], you're just using your memory. And I think we all know, that can be pretty fleeting. I think without it, you are just flying blind" (Participant 6). This comment is similar to those made by other participants concerning their ability to use mobile devices to track their TSL progress over the

long term. In other words, devices helped participants with the cognitive load of recalling their progress, which I will discuss more later on in this chapter.

Regarding failure, however, after completing a TSL requirement, a majority of the participants expressed that they would not continue tracking their progress in those activities. However, one participant illustrated an alternative view, whereby a new activity became so habitual that it was not necessary to track, though it may still be part of your everyday fitness tracking.

Furthermore, the adoption of technology devices seemed to not be affected by whether a participant needed to use a device or not, but instead it was a question of *which* device they used. One participant discussed their ownership of multiple devices, and though each device didn't do everything perfectly, they did help him in different ways: "It is the constant *this* versus *that*. It is making sure that you are keeping up on, you know, if I want to do a workout, which device should I be wearing?" (Participant 6).

When it comes to acquiring new physical fitness skills, participants expressed that the use of a mobile workout app or a tracking device such a fitness wearable provides them with the easiest way to track even the most basic metrics, as well as provide easy to follow plans, clear information and a history of activity that can be used to adjust future behaviours. If a TSL requirement was to lift a certain amount of weight, or hike a certain distance, participants were clear in their response to interview questions that their use of apps was the most direct and informative way to accomplish those goals. These responses naturally led to a discussion of a participant's interpretation of app design and how it affects their use, as I examine in the next section.

2. App Design & Use

During the interviews I explicitly asked if the design of an app contributes to how participants use it. In many of the interviews, participants expressed frustrations with apps that are poorly designed, describing some of these apps as “clunky”, “confusing” or “slow”. On the other side, well-designed apps often have an appealing aesthetic, are simple to use, run smoothly and communicate their messaging with a user well. Often, participants described in detail the kinds of features or inputs their favourite fitness apps provided, such as the type of workout or activity. Additionally, the monetary cost of an app came up as a hindrance regarding future use. For example, if the free features of an app provided enough information and feedback for a user’s purposes, they felt no need to pay for additional features. Though, if they found value in the app and adopted it into their regular use, a paywall was not an issue.

An app’s ability to store and compare data as well as communicate with the user greatly affected a participant’s attitude toward continued use and likeability. One user commented on the design of a lifting app that helped him push his abilities and lift more weight. What they described was a form of gamification, which from their description, was built into the app as a feature. “Every time that opportunity came to get that little dot to move one little step higher… I chased it so hard,” they said. “Breaking a 500-pound deadlift and then doing a 400-pound back squat. Oh, man. I never thought it was ever going to happen in my mind, you know?” (Participant 5).

Few of the participants mentioned privacy and surveillance as concerns. While there was concern regarding how much data mobile applications capture, it was not expressed as a hindrance to installing an app. Though, if the data was used to show different advertisements, they deemed that a strong enough reason to end their use. One participant said, “These apps are

collecting so much data on us that they do not need and obviously selling it to marketers. When the apps normally are good early, and then the little ad shows up... and they start getting bigger and bigger, that is normally when I just move on from the app" (Participant 5).

Interestingly, though not explicitly asked, all the participants expressed frustration with the design of the TSL mobile app as well as the website, because of design choices and a general "slowness" to how the site operates. Participants did reflect on how their use of TSL led them to use a range of other apps that helped them accomplish their goals, as I discuss in the next section.

3. Values & Goals

One of the most interesting discoveries in the data was to see the both the overlap and difference of values and goals presented in the TSL platform with the personal goals of users and the goals presented in different apps. Though participants seemed to generally share similar approaches to app use and skills development, answers regarding their personal goals differed. For example, one participant claimed they were never into fitness until they joined TSL, which motivated them to download fitness apps to their mobile device and begin tracking their progress regularly, to the point that physical activity development became a regular part of their life. Another participant expressed their indifference to physical fitness, specifically highlighting the extrinsic motivation that came from the TSL program, which motivated them to both participate in daily fitness, or physical-based TSL badges, as well as track certain distances as required. Other participants expressed that their satisfaction with their progress – both within TSL and on their personal fitness apps – motivated them to continue. Two participants spoke about their weight-loss journey as a major personal goal, and the success of that journey was due in large part to their use of apps. Other participants also reflected on the overall goal "to stay healthy"

and build upon their personal long-term fitness goals that "have always been a part of them" (Participant 6).

Finally, instances of Self-Determination Theory were evident, as expressed by participants who commented on their competency with certain activities. In most instances, they learned skills on their own and continued to perform those activities with friends and family. I discuss this theme of Skills Development more in the discussion section below.

4. Skills Development

I asked participants to comment on what skills they were able to develop as a direct result of their used of apps and devices, as well as questions around TSL's Army Ground Forces Test (AGFT), their abilities to improve their scores, and if they used tracking tools to help improve those scores. Many of the participants discussed their ability to perform certain exercises required by the AGFT including their ability to perform an increasing number of push-ups and pull-ups. While some were able to find apps that suited their needs and helped them train for the AGFT, many commented on their inability to find digital tools that helped them train for those specific activities and instead opted for more personalized versions of tracking. This suggests that Hoy is correct that a lack of personal understanding comes from a simple lack of the appropriate tools (Hoy, 2016).

One participant gave an insightful answer, saying they found it difficult to develop specific skills because of their commitment to programs and apps that focused on other skills, resulting in misaligned goals. They stated:

> "The answer is fairly obvious, because while I do strength training, and that will help my push ups and sit ups, I don't run, I don't do running training. So of course, I'm never

going to get better at it if I don't do it. So that's my weakness there. And I keep trying different ways of getting myself in there, running, so far with not a ton of success." (Participant 3).

Similarly, other participants found they developed certain skills by using apps designed solely for that skill, such as using running apps for running. One participant commented on their use of an app that helped them develop the required skills needed to complete a triathlon, saying "I use *Runkeeper* for running and biking outside, as you kind of work towards those cumulative outdoor activities" (Participant 4). While many of the interviews include mentions of specific physical activities, others mention skills in time management and in overall capabilities of "readiness", which seemed to be defined as an all-around physically skilled individual who could perform at any given time.

Generally, participants provided well-rounded comments on their success at developing skills so long as those skills were aligned with their personal fitness goals, and their personal values. While some were introduced to fitness at the start of TSL and built their skills as it lined up with their new-found interest in certain fitness pursuits, such as strength training, others adapted their current lifestyle to the TSL program requirements, such as one participant who used their hikes during hunting season to complete some requirements. Still, others developed skills only as far as was minimally required by TSL. In every case, their level of app use aligned with their level of skill pursuit.

5. Social Comparison

While my analysis found significantly fewer instances of Social Comparison (e.g. Tags of Social Comparison were around 30 versus over 100 for Technology Adoption), in almost every

interview, comparisons to others became an important topic of discussion, specifically in the context of perceived effort in the pursuit of skill acquisition. While discussions about specific app design mentioned the ability to share data with others across apps, most discussions centered around the TSL platform, with questions about who was actually "living strenuously" – a common point of contention within the TSL platforms, and specifically the Veteran's forum.

Participants also discussed how well certain skills were executed among their peers. One participant lamented that regarding the Army Ground Forces Test, most members failed to adequately perform the required skills, saying "I have had people meet up to do the ground forces test and I do not think anybody was doing every single exercise correct to form. At least one person was doing each thing wrong. It was like, wow, okay, I am the only person. But of course, I actually went and got a copy of the physical [AGFT] book" (Participant 1).

Other participants brought up inclusion of their family and friends in their fitness development as ways to improve accountability, or to create more sociability in their pursuits. One participant discussed completing requirements with his son but added that "[his son] has no idea that I am doing it for a silly little check to mark off" (Participant 5). Others also commented that within TSL, they expected more friendship or camaraderie, but often, just one controversial forum posting would lead to problems. A lack of members who were geographically close to each other was also discussed as a barrier that was difficult to overcome. Another participant specifically mentioned the difficulty in accountability for the AGFT, saying:

> "Unlike sporting events, or how the ground forces test was originally designed, you do not really have a lot of people around you. Most of the time, you're working out alone, maybe like one other person, you do not have that constant, somebody watching you.

You do not have somebody taking notes about your performance, or how many reps you did a month ago and then allowing you to kind of compare" (Participant 6).

Similarly, another participant compared the efforts of TSL members to leaderboards on other fitness apps that allow one to see other users' activity and considered whether you can trust that other users are posting correct information, saying, "I would like to have faith that everybody is doing it, but I doubt they are, right. The third day of my class, there was a dude that already had seven badges" (Participant 5). The significance here is that TSL encourages members to approach badge requirements as new skills to acquire, or at least re-attempt to develop, even if a member is already proficient in that skill or has made a successful attempt at requirement before joining TSL. Participants agreed that to see members apparently meet so many difficult requirements in such a short period of time can discourage honesty and motivation to share personal activity.

Though social comparison was generally discussed in terms of members comparing the efforts on the TSL platforms, many of the statements can be discussed as part of the social features found on fitness apps such as leaderboards, sharing of workouts and discussions around effort, accuracy, and evidence of having done the required work.

6. Tracking (or Quantified Self)

Interview questions that focused on tracking asked about habits related to the Quantified Self movement. These included asking what kind of tracking apps participants used, what activities they performed, what specific metrics they tracked, whether they found the data useful and what metrics they wish they could track but were currently unable to track. Due to the semi-structured nature of the interviews, discussions also included high-level mentions of the

Quantified Self movement, including questions about any other metrics that participants track in their daily lives beyond fitness metrics, such as financial, nutrition, sleep, etc. One participant said, “I am familiar to some degree with the quantified self concept. You are talking about the guys who will, you know, track everything? Yeah, that is not really what I do” (Participant 3). Connecting QS activities with the theme of Social Comparison, another participant said, “I feel like I am tracking and kind of keeping an idea of the environment more than my peers. Really trying to chunk out each portion of my life in some sort of quantifiable, measured role.” (Participant 6).

Discussions around the AGFT all included tracking the number of repetitions of an activity, such as number of pull-ups, push-ups, squats or sit-ups. When asked about specific metrics and data they found most helpful, all participants expressed preference for measurements of running or walking time and distance, with the occasional mention of pace. Other participants also included heart rate, which was discussed in terms of level of exertion or how hard they believed they were working. One participant commented on how tracking their workouts helped achieve desired results:

> “I think it has helped me because I can know this workout is gonna take me one hour. And I know I am gonna have a one-minute break between reps, two minutes between different exercises. Before I did that, I could spend two hours in the gym, and I felt like I was not getting the results. And it was taking me more time. So, having a timer on it and it gives you a three second countdown to your next rep, you kind of hear the beeper and things like that, it just gets to be more focused. And so, the less [you are] working that out, odds are you will do it more long term than if it turns into work, and then you fall off track” (Participant 2).

A common reflection among participants was the ability to track historic data in their workouts and know what actions they performed in order to know how to progress. This participant explained that process when building their skills in strength, while also touching upon the previously mentioned themes of design and gamification:

> "For the strong lift one, the whole idea is that you are tracking your numbers. So, you do not have to, I guess, write them down and track them yourself. So, it is useful just in that regard to see, what did I do last time? What am I now moving up to next time, in the most basic sense? But, also the fact that by following the app's program, you know, you are continuously increasing that weight. It is sort of an enforced kind of improvement, which is, of course, beneficial as well" (Participant 3).

Regarding questions about goals outside of fitness, aside from high-level impressions of their nutrition and sleep, participants failed to identify specific instances where tracking was a regular practice. Some participants mentioned the tracking of their body weight as a regular habit, though they stopped tracking those numbers due to negative connotations.

Interestingly, some users pointed to the difficulty of data input and data communication through apps proved to increase the difficulty of achieving meaningful results or developing their desired skills. One participant reflected on their run tracking. While it was a generally positive experience of looking at historic data, when it came for them to run a race, their skill level appeared to diminish. They said:

> "It was always amazing how I could always [see that] all my training runs would be good, and I would do a terrible race. So, it is funny how tracking can always show me that I would never perform when I was supposed to for runs and things like that…

> Sometimes just writing it down in a journal is better than anything I could put in the app" (Participant 5).

Overall, reflections on tracking showed how participants were given opportunities to see where they were, how they progressed, and how to plan their progression in the future. Ultimately the tracking of basic metrics proved to be the most valuable tool the participants could find that would help them achieve their goals and acquire new skills.

26. Summary of Findings

Overall, participants expressed a general affinity towards skill building, development and acquisition as related to fulfilling personal goals and using new digital technologies such as apps and devices to do so. Regarding general fitness skills and abilities, one participant commented:

> "Very few people these days, unless you are a part of the military, take a ground forces test, or do rucking, and I think it builds a lot of functional fitness. So, if I am playing with my daughter, I do not feel like I am going to die. Or I can lift an 80-pound sandbag without feeling like I am going to die. All those things, I think they translate to other stuff in your life that you cannot really tangibly quantify, right in that moment, but you can definitely say that, okay these skills that I am acquiring, these functional skills I am acquiring, would translate well somewhere else" (Participant 6).

While reasons and motivations for behaviour change differed to varying degrees among participants, all interviews provided insight into how digital tools helped individuals acquire skills. The findings also seemed to support current research into topic of behavioural change, technology adoption, and the quantified self, as will be discussed in the next section.

CHAPTER 5: Discussion

In this discussion I chapter, I reflect upon my findings from the interviews and connect the emerging categories and themes to the current literature to again show that despite new technological applications, instances of QS and behavioural design techniques are still relevant and help us understand how digital tools can aid in developing new physical skills. I begin with recalling Self-Determination Theory as a helpful framework through which we can approach the data and move on to themes of Technology Adoption, Behaviour Design, QS and Social Comparison.

Throughout the interview process, it became clear that Self-Determination Theory provides an excellent frame of reference when discussing participant's experiences with self-development and experimenting with digital tools to bring about behaviour change in order to accomplish needs of competence, relatedness, and autonomy (Ryan & Deci, 2000). Competence refers to a person's ability to perform a task, relatedness refers to how one connects and measures against peers and autonomy refers to the ability to seek, learn and acquire new skills under one's own volition.

My analysis of the data indicates that all three of those themes became evident in each of the interviews to varying degrees. Participant 6 shared an insight that showed clearly how app use and tracking can lead to more competent and autonomous individual, supporting Choe et al.'s hypothesis that increased access to data leads to more self-discovery which leads to habit building and permanent behaviour change, so long as interpretations and presentations of that data are helpful and can help a user make meaningful discoveries and change (Choe et al., 2014, Pg. 1). Participant 6 said:

> "Like with eating right, like someone who is trying to lose weight, they might use My Fitness Pal to track their calories very well. And that is something I have done in the past myself. But once you build good habits around eating, then you no longer need to track that. You have got the right habits in, right? And that feels like the approach that The Strenuous Life takes, is to build good habits so that you do not really need to worry about keeping specific numbers or keeping track of things generally you just confident in your habits that they will make things work."

We can interpret these findings in relation to the Behavioural Design Techniques discussed earlier, where the goal of tracking is to build habits to the point where users require no conscious effort and no longer need to be burdened with a cognitive load of assessing their skill progress. A successful app or device will implement positive behavioural techniques such as helpful and timely communication in order to accomplish those goals. In that sense, apps and devices are truly taking the role of a perceived companion as mentioned by Jang & Kim (2020). Ultimately, it may come to a point where tracking apps or devices are no longer needed because the individual is already meeting the required metrics, and they no longer need to carry the cognitive load, whether mentally or digitally.

Furthermore, recall the lament of Participant 1, who specifically compared his attempts at the Army Ground Forces Test against his peers. This supported his self-assessment as a completionist, who is motivated by meeting requirements with acute accuracy. Participant 1 said, "I have had people meet up to do the ground forces test and like, I do not think anybody was doing every single exercise correct to form like, at least one person was doing each thing wrong. It was like, wow, okay. I am the only person." This is an important part of SDT, where an

individual finds some value in relating to their peers. Certainly, TSL lends itself to this kind of relatedness in the form of leaderboards, accountability and requiring participants to upload proof and evidence of their efforts. While this study only considers the opinions of a small sample of self-selected members of The Strenuous Life (TSL), it may be helpful in identifying some of the motivations of users to continue in such a program as TSL. This limitation does need to be considered and future research will benefit from larger studies on greater populations, however this study does show some instances of successful behavior change techniques used both in TSL and personally chosen apps by the participants. For example, interview participants indicated their skills development is greatly assisted by helpful tools that they have implemented into daily practice. This includes experimentation with what works and what doesn't, based on a variety of factors, and finding the right tools to help with the acquisition of different kinds of skills.

Certainly, each of the participants identified different motivations for joining TSL, and further identified different motivations for using different kinds of apps based on those motivations. Congruent with the current literature, all participants involved themselves in some form of Quantified Self (QS) practice. In traditional modes of QS practice, most individuals are engaging in minute forms of tracking in order to motivate certain behaviours or bring about behavioural change. While some participants identified their main motivation to generally improve their overall fitness, others touched on specific desired behavioural changes such as weight loss, strength, or increased abilities in physical skills such as push-ups, pull-ups and running. In other words, participants who could draw on TSL-related fitness data to view progress towards their goals, such as a decrease in weight, an increase in strength, a faster running pace or more time spent with an increased heart-rate, indicated they felt more motivated to continue in those behaviours. For example, Participant 3 said,

> "I have pretty consistently improved things like my push ups and my sit-ups, but I continue to struggle with the run. As I have progressed in the program, I have also become a lot more interested in the physical stuff just more generally. I was not physically fit at all when I joined. I did not enjoy doing that kind of thing. And the program sort of helped me learn how to enjoy that. So now that is that continues to be a major part of my motivation nowadays."

Participant 4 discussed specific metrics they tracked and continue to track as they progress towards personal goals: "Weight is one, I am still overweight. So, that is one that is definitely being tracked. And then I would say per mile pace and running, and biking is one."

It's important to note the different approaches that participants expressed with respect to technology adoption. The Technology Adoption Model (TAM) considers usefulness and ease of use are the main factors in whether a user engages with a new technology. Participants made clear that ease of use of not only the fitness applications they procured but also the TSL program itself, affected their pursuits, motivations, and successes in developing their physical fitness aptitude, changing how they interacted with tools, and forcing them to think about what design features suited their needs best. Furthermore, there also emerged evidence of both intrinsic and extrinsic motivations of technology adoption (Ryan & Deci, 2000) One participant commented on the extrinsic motivation found in their membership to the TSL program that was arguably the sole factor in them engaging in any physical activity whatsoever. Other participants named family members and children as other factors that motivated them to improve and develop their skills. On the other hand, participants also noted their intrinsic motivations as their personal values aligned or moved to align with the values presented in the TSL program, in which fitness became a core principle of their lives.

Not surprisingly, participants described barriers to technology adoption and instances of discontinued use of an app because of poor design both aesthetically and functionally, as well as apps that provided little value in the data they presented, or used a participant's data in poor ways such as forcing advertising into the design. Many participants described the activity of logging their data: the easier it was to capture their fitness data, log it and communicate it back to them historically for future reference, the more likely they were to continue to use the app. Devices and apps that struggled to provide smooth logging of information ended up discarded.

I also asked participants to also consider the Quantified Self movement – that while it can be an enormous task to successfully track your personal data, whether from daily life or from fitness, arguably the bigger question to ask is, "what do you do with all that data? What good is it?" If an app captured accurate data, processed it, packaged it and presented it back to the participant in an informative and engaging way, often the participants expressed a positive reaction to that kind of app. Apps and tracking devices such as smartwatches prove to be helpful over the long term because of the ease in which participants can look over the data on a weekly, monthly and yearly basis. This helps them see their progress and shape the path forward, to improve and build their skills. Some of this is done through well-implemented features of gamification, but more importantly, it is done through a balance of usability, form and a function. While some studies show that most apps do little more than provide information (Aitken & Gauntlett, 2013), others showed that users found more satisfaction with apps that were simply easy to use (Cho, 2016). This was evident from the interviews as all participants expressed how easy it was to use their preferred app, or preferred method of tracking.

Though no explicitly asked, participant's comments also demonstrated evidence of Social Comparison as a leading factor when it came to the pursuit of skills. Though the theme never

came up in discussion about specific fitness apps and their functionality, social comparison was a major factor in their general pursuits on the TSL platform. TSL also operates as a digital platform with a heavy social component built into its use. While the program itself is built around the acquisition of skills, both hard and soft, and under different topics and subjects, from learning a new language to building a fire in the rain, the other half of the website is built with the intention of digitally sharing with other members of TSL. With that in mind, many participants commented on the "honour system" put in place whereby members are expected to complete the program requirements under the impression that are performing and sharing accurate and faithful accounts. Whether other members were indeed adhering to this honour system was up for debate among participants. This provides an excellent example of the difficulty of building digital tools that are able to track and record accurate data points about an activity without having some sort of accountability feature.

In this discussion of the findings, I recalled the findings from the semi-structured interviews which provided numerous examples and evidence of Technology Adoptions, including barriers, the implementation of Behaviour Design Techniques, Social Comparison, and the overlap of Design and personal values as elements of successful apps that seek to help users improve skills, specifically regarding fitness and physical abilities such as running, swimming, biking, strength and general physical aptitude. In the next section I make some final observations to conclude my Capstone.

CHAPTER 6: Conclusion

The main research question for this Capstone project asks: *How do mobile fitness applications and tracking devices aid their users in the development of real-world physical skills?* The abundance of these kinds of tools, their ease of access as well as the decreasing barriers to their adoption helps us understand the initial reasons why so many people turn to these tools to help them achieve desired behavioural changes. In fact, participants were quick to share their experiences and the apps they most often use early in the discussion, which is an excellent illustration of Rooksby et al.'s (2014) observation that behaviours do not change because of technology use, but rather people use technology because they want to change.

What continues to a be an interesting point of research is how users implement these tools in the long-term and whether they are successful in bringing about change in their behaviours. Many of the participants expressed positive feedback regarding their overall fitness aptitude, as well as skills in time management, skills in strength as well as running. However, when it came to the discussion of a standardized test in which specific skills were scored, participants admitted a lack of success in increasing their skills. Referring to TSL's Army Ground Forces Test which scores skills in push-ups, pull-ups, sit-ups, squats and sprints, while some participants increased their scores because of a general increase in their fitness practice and aptitude, many said they had failed to find an adequate digital training tool to help train for that specific test. In other cases, the test failed to align with their personal fitness goals, and for some, they simply reached a point where it was impossible to improve any further, having reached their max abilities based on their own training methods.

While this seems to show evidence against the helpfulness of mobile fitness apps in developing real-world physical skills, it does show that overall tracking with the aid of digital

tools does seem to help a person's overall fitness aptitude. Though, we can concede there are many ways these devices and tools can improve their methods of capturing, processing and presenting data. More research into behavioural design may help uncover exactly how apps are able to turn raw data of a person's activities into effective change. The interviews did reveal that overall, the regular use of fitness apps and the motivation found in the ability to review one's progress, and to be reminded to continue to exhibit positive effort, does result in positive behaviour change. This change can come through one singular device, or a combination of different platforms, devices, tools and communication techniques. Overall, devices that show *how* to perform a skill better and provide ways to improve based on historic user data, while also encouraging users to perform movements more often, whether through explicit motivation or more subtle behavioural design techniques, seem best equipped to help people develop real world skills. As technology continues to develop and provide more insight, users will no doubt gain a better understanding of the nuance of their activities and how to align those activities with their personal goals.

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Appendix A: Invitation Letter

Letter of Initial Contact
Richard Hillier, MACT

Research Project: How mobile fitness apps and tracking devices aid in the development of physical skills

May 1st, 2021

Hi [*Insert Name*],

My name is Richard Hillier. I'm a member of The Strenuous Life, Class 006 as well as a member of The Veterans Forum group, the Ontario Geographic group, and participate in numerous other forums on the Strenuous Life website.

I'm also a current graduate student working on my final research project for the Master of Arts in Communications & Technology at the University of Alberta in Edmonton, Alberta, Canada.

I'm reaching out to invite you to participate in my research, which is looking at how mobile fitness apps and tracking devices aid in the development of physical skills. Specifically, I'm looking to understand how members of The Strenuous Life self-development program use apps and tracking devices to help them achieve physical fitness requirements within the program and develop their skills, fitness and overall physical capabilities within the guidelines of The Strenuous Life.

If you are interested in participating, please send a private direct message to me on the TSL website or send an email to my student email address found below. Further information regarding the research and your participation will be sent upon receiving your message.

Thank you,

Richard Hillier
rhillier@ualberta.ca

Appendix B

Interview Script
Richard Hillier

Research Question: How do mobile fitness apps and tracking devices aid in the development of physical skills?

Semi-Structured Interview Questions

Introduction

1. What were your reasons for joining The Strenuous Life platform?
2. Of the TSL badges you have completed so far, which do you believe contributed most to your personal development? Why?
3. How man times have you completed TSL's Army Ground Forces Test? Have you improved your score each time? Why or why not?
4. Did you use tracking apps to help improve your scores on TSL's AGFT? How did you track your progress?
5. How have you used tracking apps or devices to develop the skills required for the barbell badge, frogman badge, rucking badge, or another fitness-oriented badge?
6. Do the requirements of the TSL Platform overlap with your personal goals? If so, how?

Quantified Self

7. Do you track any other personal development goals outside of The Strenuous Life? If yes, how do you track them?
8. Do you think The Strenuous Life Program provides adequate tracking opportunities for the development of hard and soft skills?
9. What mobile applications and tracking devices do you use?
10. What metrics are most important to you when tracking your physical activity?
11. Do you find the data captured by apps and devices meaningful and helpful? Why or why not?
12. Do you believe apps and devices have helped you increase your physical fitness aptitude and skills?
13. What kind of metrics do you wish you could track to help your development that you are currently unable to track?

Behavioural Design

14. How have you used tracking apps or devices to support your fitness goals and skills development?
15. Have you used tracking apps and devices to support your progression in the physical fitness requirements and tests within the Strenuous Life Program? How?

16. Does the design of an app contribute to how often you use it and for how long?
17. What are the main factors you look for in a fitness app or tracking devices?
18. When a TSL fitness challenge or badge requirements was completed, did you continue to track and perform that activity? Why or why not?
19. Do you continue to use tracking technologies after you've reached a goal? Why?
20. What skills have you developed that are a direct result of your use of fitness apps and tracking devices?