**Colors That Prompt You:**
**A Persuasive Ambient Activity Display—RunDrawing**

by

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A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Design

in

INDUSTRIAL DESIGN

Department of ART AND DESIGN

University of Alberta

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—RunDrawing

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# ABSTRACT

Physical inactivity, a primary contributor to excess weight and obesity, has become an epidemic. In Canada, about one in four adults are clinically obese, most have a sedentary lifestyle. People want to be fit and healthy; however, the lifestyle they want to lead is often different than the one they actually lead. Using technologies to facilitate people changing their additive behaviors has been a trend for nearly a decade and is still very prevalent and shows promise.

This thesis introduces an app, RunDrawing, which incorporates an ambient display technology to encourage individuals to participate in regular physical activity. RunDrawing was designed based on both behavioral and technology development theories as well as findings from research studies and design projects. To encourage physical activity, RunDrawing uses phone-based sensing technology that infers physical activity information in real-time, a mobile display that presents individuals' behavior information and their goal attainment, and an interactive gallery where individuals can manually view, edit, and share their "running drawings". Eleven design students and two patients with obesity were interviewed. Data was collected and analyzed to determine the perceived usability and usefulness. Suggestions for improving the concept are recommended and suggestions on future research are presented.

# ACKNOWLEDGEMENTS

First of all, I would like to express my deepest appreciation to my supervisor, Rob Lederer, who has gently guided and supported me through the 2-year in pursuit of my Masters in Industrial Design. Without his guidance, persistent help, and support, this thesis would not have been possible. I am grateful to Mary Forhan who has been generous of her time and expertise in making this project come to life.

I would also like to thank my committee members, Sue Colberg and Cezary Gajewski for their invaluable advises and their kind encouragement.

Many friends have shared their journey with me. I would like to offer my sincerest thanks, in particular: Weihuan Zhu, who has always given me inspirations and cheered me on; Hao Li who has willingly shared his precious time to explore new ideas and thoughts with me; Anson Wong, Martin CS Tee and Juan Fajardo who have been wonderful colleagues.

I would like to thank my loving parents, Xiao Wang and Huixia Liu, who have supported me without reservation. Without their encouragement, I cannot be the person who I am today.

Last but not least, I am especially thankful to the Design Center of ZTE Corporation in Shanghai. It is a privilege to be a part of such a talented group of designers. Thanks to the folks at the ZTE Design Center for being invaluable resources and patient teachers.

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# Chapter 1
# INTRODUCTION

Obesity is a serious threat to public health. The latest data from Canadian Obesity Network (CON) shows that about one in four adult Canadians and one in ten children are clinically obese, indicating that six million Canadians living with obesity require support in managing and controlling health issues associated with obesity. The prevalence of obesity is reflected in a significant risk factor for the emergence, development and worsening of various diseases such as type 2 diabetes, high blood pressure, heart disease, stroke, arthritis and cancer (Obesity and overweight, WHO; Obesity in Canada, CON).

Medications or bariatric surgery are effective and suitable for some portion of people struggling with obesity, but such treatments are expensive and often accompanied by possible side effects (Bray, 2004; Chaudhari et al., 2013). The mainstream treatment in reversing obesity trends depends on promoting widespread changes in diet and physical activity patterns (Obesity and overweight, WHO; Obesity in Canada, CON; Tang et al., 2015). Research has suggested that face-to-face behavior interventions, for example individual weight loss counseling, have proven to be safe and effective for inducing either short term or long term weight loss (Proper et al., 2003; Holt, Warren & Wallace, 2006). “I wish I could just carry you (clinician) around in my pocket to keep me on track” is a frequent comment heard from patients. However, personal trainers and clinicians cannot be available whenever and wherever patients need them, but technology might be able to bridge this gap.

With the thriving of mobile health,[1] patients can play a more active role in managing their own health without the presence of healthcare professionals as technologies such as multiple sensors, global positioning system, always-connected wireless networks, and other environmental detecting characteristics have guaranteed patients are able to receive healthcare anytime and anywhere, via their personal mobile devices which can overcome geographical, temporal, and even organizational barriers (Silva et al., 2015; Rodrigues et al., 2013). On the other hand, mobile healthcare applications (healthcare apps.) have added functionality that offers opportunity for data mining and visualization as well as delivering tailored behavior change interventions to improve and enhance patients' self-care capability. The emergence and adoption of persuasive systems in designing healthcare apps comes closer to sharing the goal of patient-centered models of healthcare. Persuasive systems, defined as "computerized software or information systems designed to reinforce, change or shape attitudes or behaviors or both without coercion or deception" (Oinas-Kukkonen & Harjumaa, 2008), can adjust what they do based on user in-put, needs, and aspirations. Such systems, like humans as "persuaders", can be designed to utilize patterns of traditional human techniques of interactive persuasion similar to social communication; however, unlike humans, they can bridge the unmet requirement of being available in real-time (Fogg, 2003). With the help of persuasive technology and with its nature of ubiquity, patients can essentially carry their "healthcare professional" in their pocket via their mobile devices. The focus of this thesis is to conceptualize and design a persuasive technology, more precisely, an ambient display[2] (described in detail in Chapter 4) to support individuals' desire to live a healthier lifestyle.

[1] Mobile Health refers to the usage of mobile communications technology & devices to enhance access to healthcare information improve distribution of routine and emergency health services and provide diagnostic services (The Mobile Healthcare Bible, 2015).

[2] An ambient display is an information provision method that allows a user to obtain information at the periphery of human perception (Wisneski et al, 1998).

In this thesis, I am focusing on trends and consistency of healthy behaviors of people rather than just one-time behavior change. Weight loss can result from the small choices an individual makes throughout the day. Making a poor decision "just this time" is not going to affect his/her weight gain, but a pattern of such decisions very well could. It is easy for people to make unhealthy choices even without conscious thought because temptations are everywhere, for example elevators are convenient as is fast food. People can lose focus if they do not think about what they are doing and choosing. Therefore, a technology to persuade people to reflect on their behavior could facilitate self-monitoring. According to self-regulatory theories and the empirical evidence from research, self-monitoring has been identified as a hallmark strategy of effective weight loss/control (Burke, Wang & Sevick, 2011; Raymond C. & Daniel S, 1993). The potentiality of self-monitoring in controlling and losing weight has been further suggested by the fact that more than 10,000 mobile apps currently offer specific weight loss/control interventions, almost half of them included self-monitoring (Azar et al., 2013; Pagoto et al., 2013).

Most apps that are using self-monitoring tools for weight loss/control purposes are largely dependent on numerical data input and output, for example counting calories in and calories out, total workout minutes, and distances of running. It is quite striking to find that data results are highly likely to be linked with patients' self-worth (Polonsky, p.101, 1999). When they see numbers appearing on their screen, they do not realize it is just a number; they imagine it is a journal of either "success" or "failure". Thus, their self-monitoring tool is acting like a critic that is telling them that they are failures as well as making them feel guilty if their numbers do not match a perceived level of success (discussed in detail in Chapter 4). Quite often, such negative emotional responses cause patients to revert back to poor health habits which directly contributes to weight regain (Bandura,1997). In spite of this, design solutions for

interventions that address effective emotional coping are missing from the design and development of weight loss/control mobile apps. Some mobile apps do include some of these strategies but rarely in the context of weight loss. Therefore, this thesis is specifically concerned with methods of data presentation to facilitate self-reflection and increase awareness of their behavior patterns in promoting changes in behavior without using raw and explicit data collected directly from devices.

Persuasive technology can be designed and used to persuade people to modify their attitudes or behaviors, and to enhance levels of surveillance over behaviors. However, very few of the persuasive systems adopted in commercially available apps succeed in doing so. One possible reason is that apps are failing to incorporate theory-based strategies that aim at promoting behavior change (Azar et al., 2013; Pagoto et al., 2013; Cowan et al., 2013). There is a lack of empathy in relating knowledge and context, making the apps difficult to assess for a particular design decision for effective behavior change, for example design for changing physical inactivity or unhealthy eating. In the field of behavioral psychology, behavior and how behavior is influenced is well studied (Consolvo, 2008). In this thesis, concepts are drawn from Social Cognitive Theory (Bandura, 1997), Theory of Reasoned Action and Theory of Planned Behavior (Ajzen & Fishbein, 1980; Ajzen, 1985), and Stage of Change Theory (Prochaska, DiClemente, & Norcross, 1992). These theories were identified in order to shape an understanding of how to design a persuasive technology that could particularly supports people struggling with obesity to live a more physically active lifestyle.

This thesis is specifically concerned with promoting changes in physical activity behavior pattern. Regular physical activity is crucial to everyone's physical and psychological health; similarly as well for people who live with obesity or are

overweight (Obesity and overweight, WHO). As a primary cause of obesity and premature mortality, physical inactivity has become a global pandemic that is affecting over one billion adults worldwide (Obesity and overweight, WHO). Regular physical activity in conjunction with healthy eating habits can effectively prevent and decrease overweight and obesity, yet patients find it difficult to integrate them into daily life. One of the greatest challenges faced by persuasive technology designers, who especially focus on the prevention and reduction of obesity, is keeping patients excited and engaged during their weight loss journey. Maintaining certain levels of physical activity, until it becomes an everyday habit, is hard and challenging; temporary changes such as the occasional "fun run" are seldom going to make contribution to weight loss, so engaging patents in their weight loss journey is critical for optimal results.

This thesis introduces a persuasive system that has been designed to encourage people struggling with obesity to participate in regular physical activity. The persuasive system RunDrawing was designed to facilitate self-monitoring of patients' physical activity patterns using a novel information presentation technology—ambient display— which subtly conveys information about patients' behavior to increase their physical activity awareness and gently persuade them to be more physically active. RunDrawing was also designed based on behavioral theories (described in detail in Chapter 2), findings from empirical investigations from studies that aim at promoting healthy behavior change (described in detail in Chapter 3), and persuasive design principles and strategies that have been proposed by design researchers (described in Chapter 4).

This thesis is divided into seven chapters. Chapter 1 includes a general introduction to the research study. Chapter 2 contains overviews of the three behavioral theories—Social Cognitive Theory, Theory of Reasoned Action and Theory of Planned Behavior, and Stage of Change Theory. Aspects of the theories that are most relevant for the design of persuasive technology to facilitate healthy behavior change are highlighted. In Chapter 3, several empirical studies which have developed persuasive technologies for the particular purpose of improving an individual's awareness to facilitate behavior change and how these evaluations and discussions influence the design and conceptualization of RunDrawing, are presented and discussed. Chapter 4 introduces persuasive design principles and strategies suggested by design researchers which provided a foundation to the design of RunDrawing. These principles and strategies include the following: Fogg's 'Eight-Step Design Process' (2009), Matthews, Forlizzi, and Rohrbach's 'Glanceable Display Design Principles' (2006), along with a set of strategies established by Consolvo (2008). A new design strategy that seeks to further perfect Consolvo's strategies is also introduced in this chapter. Chapter 5 describes the design and conceptualization of the RunDrawing system for this thesis research project. Chapter 6 focuses on the evaluation and data collection of RunDrawing through participants' reactions to the main components of the system, and provides findings of the study. Finally, in Chapter 7, contributions, opportunities for future research and development directions are summarized.

# Chapter 2
# BEHAVIORAL THEORIES

The design of the persuasive technology to promote physical activity behavior change for this thesis project was driven by several behavioral theories from psychology related research and empirical projects (described in Chapter 3). This chapter highlights aspects of the three theories that most influenced the design of RunDrawing: Social Cognitive Theory (Bandura, 1997), Theory of Reasoned Action and Theory of Planned Behavior (Ajzen & Fishbein, 1980; Ajzen, 1985), and Stage of Change Model (Prochaska, DiClemente, & Norcross, 1992). An overview of each of the theories is provided, while highlighting the relevant aspects of these theories that influence the design of persuasive technology to encourage physical activity.

## 2.1 Social Cognitive Theory

The Social Cognitive Theory was originally derived from Robert Sears's Social Learning Theory and was modified by Albert Bandura in 1962. The theory provides a framework for understanding, predicting, and changing human behavior through the understanding of reciprocal relationship between persons, environments, and behavior. According to Bandura (1997), self-efficacy is the central construct within Social Cognitive Theory and has a direct effect on human behavior and is the most powerful predictor of behavior. Self-efficacy is defined as "people's judgments of their capacities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1997); simply put, self-efficacy is a person's confidence in his/her ability to perform a behavior.

In Bandura's research, several strategies that could foster self-efficacy include the following: (1) increase mastery through providing people with goal related experience and training; (2) role modeling with whom the individual can identify; (3) verbal persuasion that expresses confidence in the individual's ability to perform the behavior; (4) provision of feedback and rewards; and (5) proximal goal setting. Among all the strategies, the importance of providing feedback regarding how the individual is progressing is also emphasized in Lock and Latham's (2002) Goal Setting Theory:

> People need feedback that shows progress and guidance toward their goals… Simply setting a goal to them and then providing no information about their goal attainment defeats the purpose of goal setting as people doesn't know what they are doing, it is hard or impossible for them to adjust the level or direction of their effort to match what the goal is requiring….

Providing rewards is another form of feedback that people should receive when goals are met or as people are making progress towards goals. But what should the rewards be, and what are the criteria that designer should follow in terms of designing a better reward system that would motivate people more? Recently, *gamification* (Pelling, 2003), a term that refers to the use of game like elements in none game environments, has been used with varying success. Points, virtual money, trophies and badges can be effective and influential for driving user engagement, but also can fail because of the mismatch of reward to people's inherent interest.

In commercially available healthcare systems these days, the adoption of gamification theory in designing the reward system is prevalent. In many cases, virtual rewards can prove to be motivating, satisfying, and desirable enough that many participants wanted them even though they knew they were not accurate representations of what

they had accomplished (Fritz et al., 2014). However, in the recent research of Munson and Consolvo (2012), the researchers found that the rewards were not valued by participants and did not affect participants' level of activity. Researchers were surprised by this result and identified possible reasons the rewards were not appealing to the participants: (1) the trophy-like rewards design seemed "childish" to most of the participants; (2) rewards and incentives were given too late until goals are achieved; and (3) they lacked variety.

Emotional coping, an individual's ability to deal with emotions related to behavior change, is the final internal factor for Social Cognitive Theory (Bandura, 1997). Changing a behavior may evoke emotions like distress, helplessness or even hopelessness. Oftentimes poor coping skills from individuals cause them to revert back to poor health habits, most commonly found in people suffering from addictions and obesity. In Social Cognitive Theory, an individual's emotional state is thought to play an important role in perceptions of ability to maintain and change behavior. As Bandura (1997) stated, "people also rely partly on their somatic and emotional states in judging their capabilities." "Pleasant" and "aversive" feelings may serve as "incentives" and "disincentives" to influence behavior. According to Bandura, to mitigate "aversive" feelings and increase "pleasant" feelings, it is vital that health educators or persuasive technology designers teach and incorporate stress management skills which encompass many activities like relaxation techniques, mindfulness, or even therapy in counseling. It is important to help the patients to reduce their stressors and help them sustain a positive mindset when they feel challenged by changing their behavior.

## Implications of Social Cognitive Theory for Design

In the case of applying Social Cognitive Theory to inform the design of persuasive technologies to encourage physical activity for people living with obesity, Bandura's findings suggest that individuals should receive feedback regarding how they are progressing, for example using visual imagery as a form of feedback to compare the current and desired outcomes of physical activity, and indicate how far the individual has gone. The persuasive technology should also provide incentives and rewards as individuals make progress towards their goal, rather than reward them only if they achieved the goal, as this can hinder performance and lower the physical activity commitment. The incentives and rewards should match the individual's inherent interest, based on the understanding of what user craves in terms of rewards, and how the rewards fit into the initial intention of the product. The persuasive technology should also be designed to help patients reduce their stress and other negative emotions during their weight loss/control journey or to incorporate creative methods to boost positive emotions along the journey.

In Chapter 5 and 6, how Social Cognitive Theory is specially embodied in the design of the RunDrawing system is discussed. An overview of another behavioral theory that also influenced the design of RunDrawing, the Theory of Reasoned Action and Theory of Planned Behavior, is discussed.

## 2.2 The Theory of Reasoned Action and Theory of Planned Behavior

The Theory of Reasoned Action was first proposed by Alzen and later completed by Ajzen and Fishbein (1980). The key application of Theory of Reasoned Action is assessment of behavioral intention, spanning assessment of attitude, and predictions of behavior. It is based on the assumption that intention is an immediate determinant of behavior, and that intention, in turn, is predicted from attitude and subjective (social) norm factors. To put the definition into simple terms: individuals' behaviors are predicted by their attitudes about performing the desired behavior and how they think other people would feel about them if they performed the behavior.

The components of the Theory of Reasoned Action are three general constructs: attitude (A), subjective norm (SN), and behavioral intention (BI) (see Figure 2.2.1). The attitude towards the act (A) is the depth of the person's beliefs and the positive or negative value a person places on the results of this behavior (W1). A person's subjective norm (SN) is the strength of the person's beliefs about whether the significant others want them to perform the behavior (or not) and the strength of the person's desire to please those people (W2). In this case, an individual's behavioral intention (BI) equals: A (W1) + SN (W2). In addition to its powerful force in behavior prediction and assessment in general, the Theory of Reasoned Action has proved to be a theoretical framework that has been successful specifically in furthering our understanding of physical activity uptake and adherence.

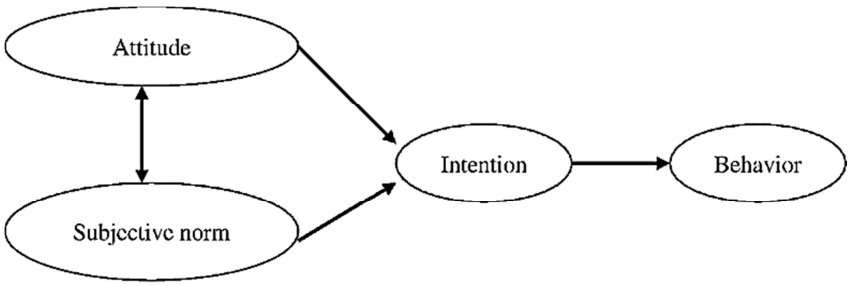


**Figure 2.2.1 Images of Theory of Reasoned Action**
Three constructs: attitude (A), subjective norm (SN), and behavioral intention (BI).

In 1985, Ajzen has proposed an extension of the Theory of Reasoned Action, which he called the Theory of Planned Behavior. It is the same as the Theory of Reasoned Action, but incorporates the notion of "perceived behavioral control" as illustrated in Figure 2.2.2. Perceived behavioral control is defined as "the perceived ease or difficulty of performing the behavior" (Ajzen, 1991).

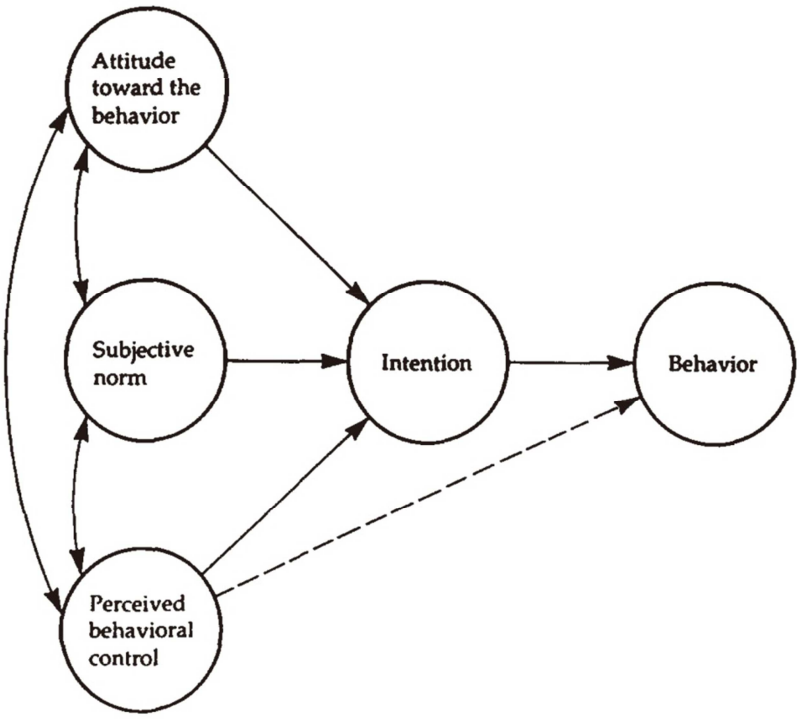


**Figure 2.2.2 Images of Theory of Planned Behavior**
Source: Ajzen, 1985

The underlying concept of the Theory of Planned Behavior, which is different from the Theory of Reasoned Action, is that it postulates that even though individuals' attitudes and subjective norms are positive, their intentions may not be strong if they believe they do not have the resources or opportunities to perform the behavior (low perceived behavior control). The more perceived ability to actually activate the desired behavior, the greater should be their perceived behavioral control over the behavior, and thus the greater the chance of successfully changing the behavior. Conceptually, the perceived behavioral control concept is similar to Bandura's self-efficacy construct from Social Cognitive Theory that was just described (Dzewaltowski, Noble & Shaw, 1990), but the Theory of Planned Behavior provides a "more general framework of the relations among beliefs, attitudes, intentions, and behavior" (Ajzen & Madden,1986).

In the Theory of Planned Behavior, Ajzen argued that individuals' ability or the perception of their ability to actually perform the behavior is not only going to affect intention, but also the actual active in doing the behavior all together. Perceived behavioral control, attitude, and subjective norm are all postulated to predict intentions and behaviors.

## Implications of Theory of Reasoned Action and Theory of Planned Behavior for Design

The Theory of Reasoned Action and the Theory of Planned Behavior explains aspects of a behavior that can be formed and changed. An individual's original behavioral attitude is important, but sometimes difficult to change as it is tied to an individual's internal beliefs. However, external factors, such as subjective (social) norms, can also be very influential on an individual's decision making. Individuals attempt to manage the impressions they want others to have of them because they care about how others

think of them. Thus, persuasive technologies to encourage physical activity should support the need of impression management and the social implication. For example, the individual may want to hide some secrets in front of other people; persuasive technologies should support them in such situations, making the individual feels more comfortable and less embarrassed while in the presence of others.

## 2.3 Stage of Change Model

The Stage of Change Model describes the stages of change through which people progress to intentionally change and modify addictive behaviors. The five stages include the following: (1) precontemplation, (2) contemplation, (3) preparation, (4) action, and (5) maintenance. Identifying an individual's stage in the change can facilitate designers' efficiency in implementing and matching the most appropriate intervention strategies (O'Connel & Velicer, 1988). The stages are defined by Prochaska, DiClemente, and Norcross (1992) as follows:

(1) "***Precontemplation*** *is the stage at which there is no intention to change behavior in the foreseeable future"* (p.3). In this stage, whether individuals recognize they have the behavioral problem or not, they have no intention of changing.

(2) "***Contemplation*** *is the stage in which people are aware that a problem exists and are seriously thinking about overcoming it but have not yet made a commitment to take action"* (p.3). The contemplators basically know what they need to do, but are not ready to do it.

(3) "***Preparation*** *is a stage that combines intention and behavioral criteria. Individuals in this stage are intending to take action in the next month and have unsuccessfully taken action in the past year"* (p.4). Individuals in the preparation stage have often made some reductions in the problem behavior, but not enough to have reached the criterion of effective action.

(4) "***Action*** *is that stage in which individuals modify their behavior, experiences, or environment in order to overcome their problems. Action involves the most overt behavioral changes and requires considerable commitment of time and energy"* (p.4). Individuals in the action stage have successfully altered their behaviors and begin to show new behavior consistency.

(5) "***Maintenance*** *is the stage in which people work to prevent relapse and consolidate the gains attained during action" (p4).* In the maintenance stage, individuals have successfully modified their behaviors for at least six months. In this stage, some behaviors can become a life time habit.

## Implications of Stage of Change Model for Design

As Chapter 4 will suggest, the persuasive technologies to encourage behavior change need to match and target the individual's current stage, which makes the Stage of Change Model a valuable application to identify the target user group for RunDrawing. As findings from Chapter 6 will indicate, results are not likely to be positive if the individual's current stage in change is mismatched the intervention. For example if the intervention is targeted at individuals in their preparation stage, while most users are in their maintenance stage (discussed in details in Chapter 6). When using the Stage of Change Model to guide the design of persuasive technologies to promote

physical activity, a design for individuals in their precontemplation stage might focus on education on the consequences of the problem behavior to the individual. However, in real world cases, researchers suggested not wasting time on these people as they are unaware of their behavioral problem and have no intention to change. For individuals at the contemplation stage, focusing on techniques and strategies to raise individuals' self-efficacy is beneficial; for example incorporating barrier-overcoming strategies, persuasive communications, and role modeling. For individuals in the preparation stage, it is better to focus on providing feedback and rewards and effective goal setting in order to encourage physical activity behavior consistency. For individuals in the action stage, a focus on positive emotional coping, journaling, and self-tracking of progress in order to sustain adherence is preferred. For individuals who are maintainers, it is best to focus on advanced skill-building, social comparison, and past success in order to prevent relapse and maintain behavior consistency.

## 2.4 Chapter 2 Summary

In this chapter, three behavioral theories were reviewed and discussed, highlighting the aspects of the theories that influenced and guided the design of RunDrawing. Two of the theories, Social Cognitive Theory and the Theory of Reasoned Action and Theory of Planned Behavior, are often used to understand, predict, and change human behavior. Social Cognitive Theory especially emphasizes the importance of self-efficacy as one of the key constructs to influence behavior. It describes different ways to raise self-efficacy which are found to be very useful in developing health interventions to encourage individuals to incorporate regular physical activity into their everyday life. The Theory of Reasoned Action and Theory of Planned Behavior

focuses on constructs of attitude, subjective norm, and perceived behavioral control, which helps to explain and analyze the variance in behavioral intention.

The Stage of Change Theory, however, describes the stages through which people progress to intentionally change and modify addictive behaviors. Identifying an individual's stage in the change largely helps designers to be more efficient in implementing and matching the most appropriate intervention strategies.

In the next chapter, several empirical projects and studies, that use persuasive technologies for the particular purpose of affecting individual's awareness to facilitate behavior change, are presented and discussed.

# Chapter 3
# CURRENT RESEARCH AND DEVELOPMENT EFFORT AND APPLICATIONS

In addition to the fundamental behavioral theories outlined in Chapter 2, the design of RunDrawing was also informed by projects and studies that involve the implementation of self-monitoring interventions that promote effective behavior change. This chapter presents and discusses several empirical projects and studies that developed persuasive technologies for the particular purpose of affecting individual's awareness to facilitate behavior change. Aspects of the designs that were particularly effective or ineffective at encouraging behavior monitoring and their use of technology are highlighted, as these results informed and influenced design decisions for RunDrawing.

The first two projects—*Fish'n' Step*s and *Forest*—use stylized displays that promote individuals' self-awareness for behavior change. The remaining three projects, *Shakra*, *ActivMON* and *UbiFit Garden*, facilitate self-monitoring and the increase of physical activity.

## 3.1 Stylized Displays to Encourage Behavior Change

### *3.1.1 Fish'n' Steps*

*Fish'n' Steps* (Lin et al., 2006) is an application that incorporates calm technology[3]

[3] As Weiser and Brown (1995) defined, "a calm technology will move easily from the periphery of our attention, to the center, and back." Calm technology attempts to reduce the attention required to acquire information.

and social dynamics in the form of a social computing game to encourage people to change their behavior by motivating them to take more steps every day. Users daily step count is closely related to the emotional states and the growth of their virtual fish pets in a shared virtual fish-tank (see Figure 3.1.1.1). The fish's appearance changes during the week according to whether the user has exceeded a predefined weekly goal or not; that is, the fish becomes larger every time when the total step number exceeds the target number (see Figure 3.1.1.2). At the same time, the fish's facial expression also changes according to whether the user achieves the daily goal or not (happy face represents sufficient progress, angry face represents near-sufficient, and sad face represents insufficient progress) (see Figure 3.1.1.3). *Fish'n' Steps* uses not only positive reinforcement to reward sufficient step count, but also punishment for a lack of the desired behavior (low step count leads to unreached predefined goal). As four users share one fish-tank, each user's behavior affects the entire tank: if any of the team members is deficient in their required total step count, the tank's water will get darker and the fish-tank's decorations, such as plants and animals, will be removed. Additionally, *Fish'n' Steps* also provides opportunities for users on the same team to check each other's progress and chat over an anonymous chat application.

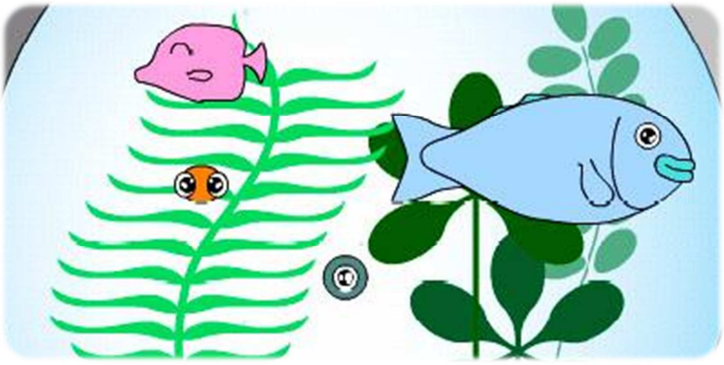

**Figure 3.1.1.1 Images of Fish'n' Steps.**
The virtual fish tank, shown with multiple users' fish
Source: Lin et al., 2006

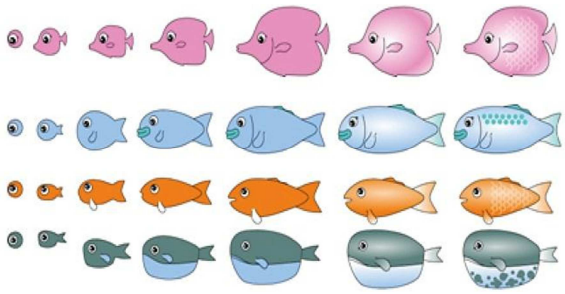

**Figure 3.1.1.2 Growth levels for various fish**
Source: Lin et, al.,2006

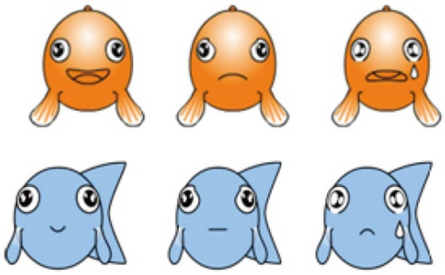

**Figure 3.1.1.3 The three types of facial expressions.** Source: Lin et, al.,2006

In terms of evaluation, *Fish'n' Steps* was evaluated in a fourteen-week study with nineteen participants who had sedentary jobs (N=19, 11 female/8 male, aged 23-63). The researchers found that some participants ignored the display when their fish were not happy, causing the researchers to rethink about the use of punishment. It seems punishing users for not reaching their goals may activate negative emotions of users which leads to avoidance or abandonment of using the application rather than encouraging the desired behavior change. Another finding that is particular relevant to RunDrawing is that the initial fascination with the virtual fish pet subsided after the first two weeks which makes continuing the game unnecessary. The main reason for initial enthusiasm wearing off is probably because the fish-tank lacks sufficient variation of change. The variety of what *Fish'n' Step* offers is limited while the users are looking for new surprises. Users soon find the pattern of the fish-tank eventually becomes predictable after a few weeks' time.

In general, *Fish'n' Step* successfully increased several participants' awareness of their levels of physical activity. At the same time, it helped participants increase a certain level of physical activity in a fun and engaging way. It is also interesting to note that *Fish'n' Steps* attracted the interest of other users who were not participating in the study which in turn indicates that the design successfully created initial excitement due to its unique and aesthetically pleasing graphic display.

### *3.1.2 Forest App*

*Forest* App is a smartphone application designed to help users stay away from their smartphones and stay focused in the present. It was described as "the best solution to beat phone addiction." This app intended to help people stay focused in different scenarios, such as working at the office, studying at the library and even gathering with friends. The app gives users a virtual land to plant virtual trees. The longer time that people stop "phubbing" their phones, the lusher their forest becomes, that is—the final look of users' forest is largely dependent on their concentration on their primary tasks at hand (see Figure 3.1.2.1).

Users will be rewarded with a full growth virtual tree after they have stayed focused for a designated time (see Figure 3.1.2.2). However, if users cannot resist the temptation and choose to leave this app to check on other applications on their phones, such as login to social network or play a game, then, as a consequence, users will get a withered tree that will be shown on their forest interface (see Figure 3.1.2.3). After users have planted a seed (set the time they want to be concentrated), this app offers a clear presentation of users' tree status (the tree is gradually growing bigger) and time frame (time is counting down) along with some messages, such as "stop phubbing" or "hang in there" to nudge users not to give up (see Figure 3.1.2.4).

The *Forest* app launched in May 10th, 2014 and soon became the top product of 'Product Hunt' with many compliments from users. A great number of users appreciated the idea of "stay focused, be present" (Forest Rating and reviews) and the "beautiful aesthetic pleasing design" (Forest: Stay focus, be present on the App Store on iTunes).

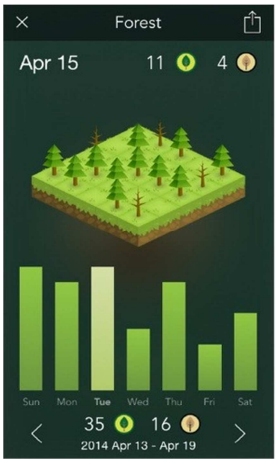


**Figure 3.1.2.1 Images of Forest interface**
Each matured tree represents 30 minutes concentration on primary


**Figure 3.1.2.2**
A matured tree will be shown when user successfully focused over a designate time. This full growth tree will then appear on the main forest interface.Source: screen shots of Forest application by the author

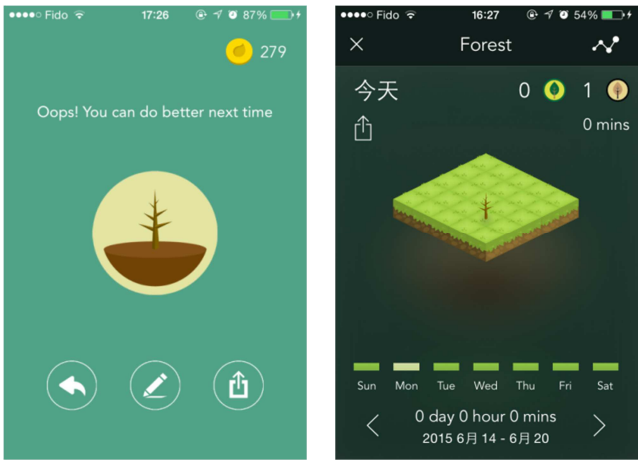


**Figure 3.1.2.3.** A view of a withered tree when the user cannot resist the temptation. This withered tree will be shown on the interface of the forest.

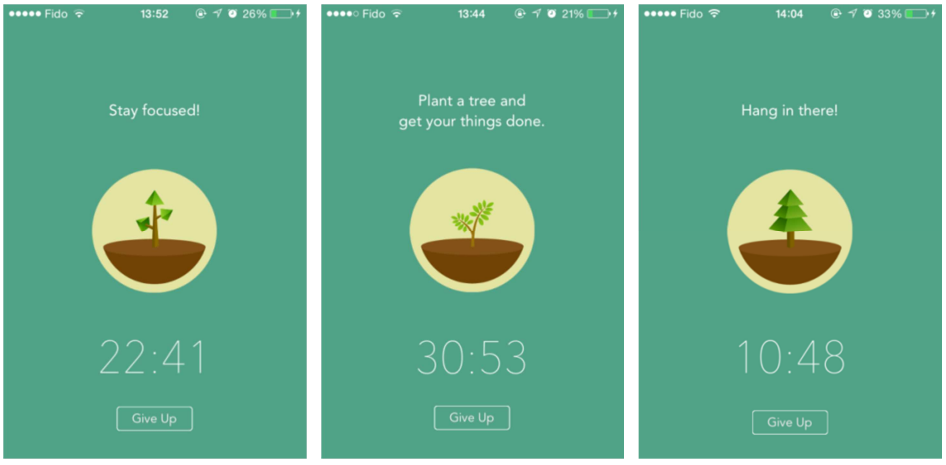


**Figure 3.1.2.4. Tree statuses.** The Growth levels of the tree at different stages of time.

According to the reviews, many users commented that the app has helped them foster a stronger focus on the present with minimal distraction from their phones, which in turn makes them become more productive during the day. However, users also listed things that should be improved by the design team and these comments largely influenced the design decision making of RunDrawing. First, the app only offers limited types of trees. Even the latest version only added three different looking trees (their first version only contained one type of tree). Users expected to have flowers, animations and more colors rather than just green trees. Second, users are unable to see any information about time and the growth level of their trees after their phone screens automatically shut down for battery-saving purposes, which restricts the users' sustained awareness as they cannot track their behaviors unless they unlock their phones for information updates. However, frequently unlocking the phone to check status distracts users from concentrating on their work and actually increases the interaction between users and their phones which goes against the app's initial spirit: "stay focused, stop phubbing." Third, users found it annoying when the app sends them push-notifications every time their trees are matured as it interrupts them from concentrating on their work. *Forest* app requires a thoughtful way to remind users of their commitment in a more subtle manner, that is—the app should reduce the attention and action required to acquire information about users' behavior so that users can focus on their primary work without the feeling of being disturbed.

## 3.2 Phone Based Apps or Programs that Encourage Self-monitoring

An increasing number of research projects use mobile phones as a platform to encourage individuals to self-monitor and increase physical activity. (Consolvo, 2008, Kriwan et, al., 2013, Munson and Consolvo, 2012, Khalil and Glal, 2009, and Maitland

et, al., 2006). However, three projects are of particular relevance to the work presented in this paper: *Shakra, ActiveMON*, and *UbiGarden*.

### *3.2.1 Shakra*

*Shakra* (Maitland et al., 2006) is a system that encourages people to increase their level of physical activity through minimal user intervention—that is, the system auto-tracks the activity level of the users and the users' current mobility state in real-time and presents the behavior information using dynamic cartoons (see Figure 3.2.1.1 ). If the system detects users have no movement at a particular moment, the corresponding cartoon will be labeled as "sedentary." If users are having moderate activity, a superwomen cartoon will appear on the screen and will be labeled as "walking." If travelling in a car, bus or train, these movements will be all labeled as "driving." *Shakra* also does not use any separate device other than mobile phone to detect physical activity as the mobile phone is a device that the users are already carrying with them every day and *Shakra* does not want to introduce new devices that users would forget to wear or bring.

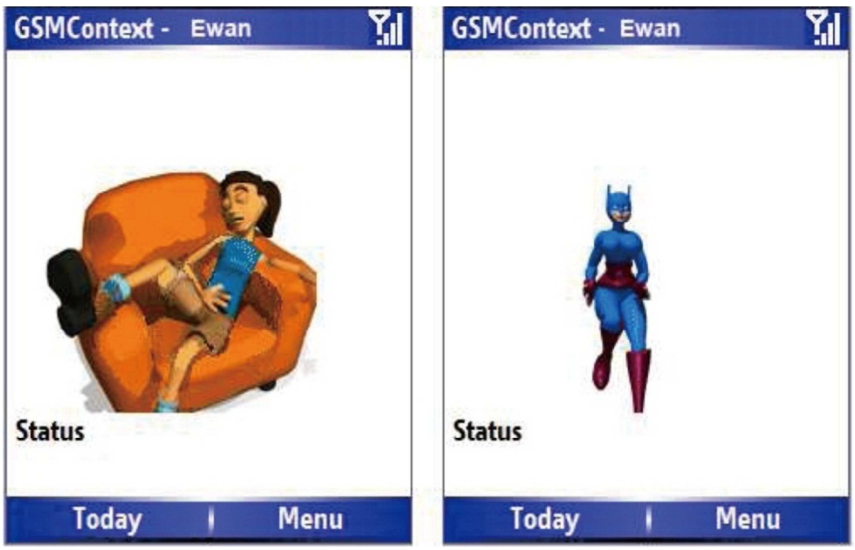


**Figure 3.2.1.1 Images of Shakra.** From left to right: the user's current activity is sedentary; the user's current activity is walking. Source: Maitland et al., 2006

*Shakra* was evaluated in a ten-day trial (N=9, 5 female/4 male, aged 19-54). The first three days required users to fill out an activity diary, the next two days were used to train them to use the system, and the final five days were used to test the system to see if the system could increase users' awareness of their activity level and if it could motivate them to be more active. Researchers found that the use of real-time behavior feedback gave the participants "good awareness of their activity level" which in turn resulted in some increase in physical activity in a non-intrusive manner. The simple and straight-forward cartoon visuals, as awareness elements, were presented in a way that users could easily associate with and understand. The cartoon visuals also provided frequent opportunities for self-reflection so that users would more likely be provoked to change or modify their behavior upon seeing those visuals. The drawback of this study is that researchers did not know if the participants would retain the initial enthusiasm and continue to feel motivated due to the insufficient evaluation time of the system. Also, the long term effectiveness of cartoon presentation was not addressed.

### *3.2.2 ActivMON*

*ActivMON* (Burns, Lueg, & Berkovsky, 2013) is a wrist-based ambient display that tracks users' activity level using sensors and represents their activity level using a continuous color spectrum that goes from red to green. If there is no activity performed on the first day of work out, red will constitute the whole screen. If the current activity level increases, the color would change from red through yellow and finally to green (see Figure 3.2.2.1). At the end of each week, users' average historical activity levels are calculated and a new goal for the coming week—10% higher than the average historical activity level of the past week—is automatically set by the system. Users must maintain the new activity level as a combined daily average; the first time

they do not, they will receive a yellow indication. If users stay below average in the following days it will result in their new average activity level for this week dropping even further. As a consequence, they will see a red color. If users compensate for their inactivity continually with their activity level high above the average over the next few days, they might finally get this week's average activity level 10% greater than the previous week and resulting in a green indication. In order to keep the screen green, users would need to maintain a consistent level of activity; otherwise, inactivity would cause the light to slide back to yellow and even red.

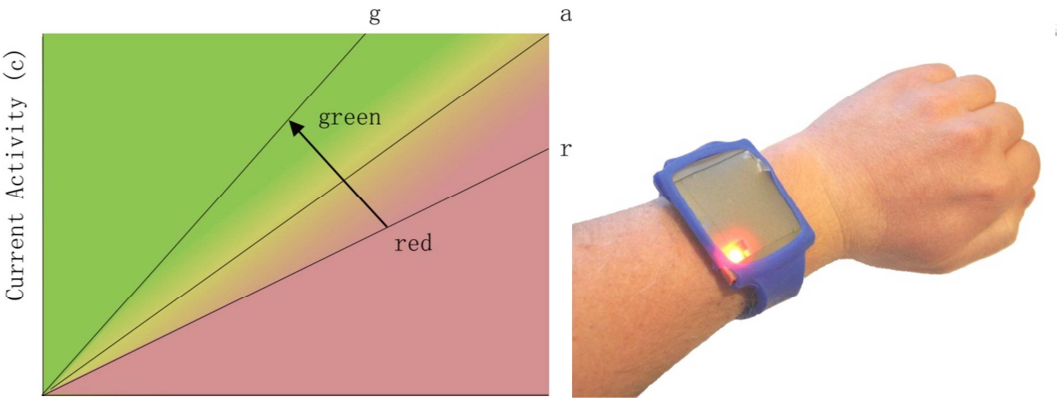


**Figure 3.2.2.1 Images of ActivMON ambient display**
From left to right: ActivMON's color visualization; ActivMON on a user's wrist. Color changes from red to green according to users' performances. Source: Burns, Lueg, & Berkovsky, 2013

*ActivMON* was evaluated in a pilot study over two weeks. (N=5, 3 female/2 male, no age range specified). Researchers discovered that users were satisfied with this less complex interface and found it simpler to engage with. The strategy of using data abstraction rather than raw data collected from technology to represent behavior data helps users to reflect on their behavior more directly. Looking at the color visualization, users know their physical activity level and their goal attainment. Moreover, representing physical activity level into a "smoothed" visualization in real-time depends on user's everyday performances, allowing users to focus on trends and consistency of their behavior rather than just short-term behavior changes.

In terms of drawbacks, researchers found that *ActivMON* is lacking in privacy as the visualization provided may draw the unwanted attention of others through others knowing the user is monitoring his/her activity level. In order to prevent this, *ActivMON*'s visualization needs to be presented in a more inconspicuous way, using common graphics that others may have already encountered in their everyday life which will not draw unwanted attention.

### *3.2.3 UbiFit Garden*

*UbiFit Garden* (Consolvo, 2008) is a mobile phone-based system that was developed to encourage users to self-monitor their physical activity level. Unlike *Shakra* which uses phone-based sensors, *UbiFit* system uses an additional recognition device to detect physical activity. One of the key components of this system is using a stylized garden visualization to display users' weekly physical activity information on the background screen of users' personal phone (see Figure 3.2.3.1). Different colors and types of flowers represent different physical activities, such as walking, running, and cycling. Different colors of butterflies represent users' goal attainment—a yellow butterfly indicates that a primary weekly goal was achieved, while a white butterfly indicates that a secondary weekly goal was met. The garden will bloom progressively throughout the week as more healthy behaviors are performed. The use of the garden visualization that resets in the background screen makes the garden visible each time the phone is used. Every time people use their phones to answer a text message, make a phone call, or check the time, they also see this representation of their level of physical activity that reminds them of their commitment to being physically active.


**Figure 3.2.3.1 Images of *UbiFit's* display**
From left to right: UbiFit's garden displays on the phone's background screen; different types of flowers represent different types of physical activities that the user performed this week (walking, cardio, strength training, and stretching). The butterflies indicate if the weekly activity goal was met this week (a yellow butterfly indicates that the primary weekly goal was achieved; a white butterfly indicates that the secondary weekly goal was met).
Source: Consolvo, 2008

A 3-month trial of *UbiFit* demonstrated the success of this approach in affecting behavior change (N=28, 15 female/14 male, aged 25-54). Researchers found that participants who used the garden display on the background screen of their phone managed to maintain their weekly level of physical activity during the 3-month trail compared to those who did not have the display. Their average activity level dropped significantly during this period for those who did not have the display. Study interviews also revealed that the garden display provided frequent opportunities for reflection as the garden visualization being on the background kept participants' level of physical activity and their commitment of being active in the forefront of their consciousness. The garden metaphor was considered to be an easily understood representation of physical activity behavior and goal attainment which "even small children can understand."

Study interviews also revealed some issues that should have been addressed in the design of the *UbiFit Garden* display. Some participants, especially men, suggested that the garden visualization was too feminine. The system should provide a variety of

themes from which to choose to cater not only individual preference, but also to prevent boredom overtime. Participants frequently asked if the external sensor devices could be integrated within their phone so that no more additional devices would be required to carry.

## 3.3 Discussion

*Fish'n 'Steps, Shakara, ActivMON, and UbiFit Garden* have taken important steps in using stylized representations to encourage and facilitate behavior change by trying to integrate simple activity monitoring technologies with intuitive design thinking to motivate behaviors. Although *Forest* App does not specifically address physical activity, but focuses on restricting phone usage during important occasions, it has taken an important step in proving the use of stylized displays as not only a promising avenue for prompting behavior change in physical activity, but also as suitable for a variety of health behavior changes.

The results of the pilot studies offer important implications for designers to assess decisions when creating persuasive technologies to promote physical activity. The results of *Fish'n' Step's* pilot study confirms the results discussed in Social Cognitive Theory (introduced in Chapter 2) that is, focusing on using positive reinforcement of healthy behavior rather than punishing users for not successfully performing the healthy behavior. The results of *Fish'n' Step, Forest, ActivMON,* and *UbiFit Garden* proved that using understandable and aesthetically pleasing visualizations to represent users' behaviors and goal attainment, rather than using explicit raw data presentation, are more likely to motivate behavior change as they are easier to engage with. *Forest* App's and *UbiFit Garden*'s pilot studies suggest an important design

consideration which is utilizing individual's mobile phone's background display to provide behavior information. Doing so increases the accessibility of the behavior information and thus supports individuals' abilities to stay engaged with thoughts about their health throughout the day. They also emphasize the fact that feedback should be delivered in a non-disruptive way allowing users to ignore the data while they are concentrating on other issues. *ActivMON* and *UbiFit Garden* suggest the importance of the display not drawing the unwanted attention of others, if possible (which ties back to the concept from the Theory of Reasoned Action and the Theory of Planned Behavior discussed in Chapter 2). One aspect that is lacking from all the projects is the possibility of infinite variability. The experiences with fish-tank in *Fish'n' Steps*, the trees in *Forest*, the cartoons in *Shakra*, the color spectrum in *ActivMON*, and the garden in *UbiFit* all become less engaging because they eventually become predictable rather than delivering new features and content to cater to the users' desire for novelty and surprises.

# Chapter 4
# DESIGN STRATEGIES AND PRINCIPLES FOR LIFESTYLE BEHAVIOR CHANGE PERSUASIVE TECHNOLOGIES

Previous chapters suggest that designing persuasive technology to help people build a habit towards a desired lifestyle is complex. Behavior change technologies have to be fully integrated into individual's everyday life in order to persuade individuals to change their behavior and then to sustain the changed behavior so that it becomes a habit. Several researchers have put a lot of effort into developing frameworks and approaches to guide the design persuasive technology (for example, Batsaikhan, 2014; Ayubi, 2013; Rita O, 2014 and Salvador, 2012).

An eight-step design process is adopted to inform the early-stage design of the RunDrawing to support patients' desire of lifestyle behavior change. These steps are drawn from BJ Fogg's 15 years of studying persuasive technologies and these studies have been a very useful guideline and widely employed by persuasive technology designers (Fogg, 2009). The eight-step design process was then expanded by Matthews, Forlizzi, and Rohrbach's 'Glanceable Display Design Principles' (2006) along with a set of strategies established by Consolvo (2008). A new strategy proposed by the author to further perfect Consolvo's strategies is also introduced. The newly developed strategy is based on the theories and the related behavior change projects, described in Chapter 2 and 3. All the design principles and strategies introduced in this chapter provided a foundation for the design and development process of RunDrawing (discussed in detail in the following Chapter 5).

## 4.1 Eight-Step Design Process (see Figure 4.1)

Failures in building persuasive technologies for behavior change greatly outweigh the successes. Most of the persuasive systems introduced at conferences or posted online are the few that show promise (Fogg, 2009). In order to increase the chances of success with persuasive design projects in the early stages, I adopted Fogg's 'Eight-Step Design Process' for my own project.

### *Step 1: Choose a simple behavior to target*

Select the smallest, simplest behavior that matters to target for change, rather than a goal that is too vague and ambitious. Achieving a small goal was a good starting point in achieving the larger goal as it may have bigger effects than expected: doing small things naturally leads people to adopt more ambitious behaviors, even without a bigger intervention. Smoking cessation and weight loss are targets that are too ambitious for a design team that has never before created a persuasive technology and should be reduced to smaller goal that is something more useful and objective for the early design purposes (Fogg, 2009). According to Fogg, there are two ways for breaking down a large, vague goal: (1) a small goal can be an approximation of a larger objective; (2) a small goal can be a first step in achieving the larger goal.

As previous chapters have indicated, I decided to target the behavior of self-monitoring and its frequency. According to empirical evidence, self-monitoring has been identified as the "cornerstone" and the most effective technique used in behavioral interventions of obesity (Burke, Wang & Sevick, 2011; Raymond C. & Daniel S, 1993). Specifically, highly frequent and consistent self-monitoring, rather than just some self-monitoring, can be crucial for effective weight loss and

maintenance of weight control (Kerri N. & Daniel S, 1998). Thus, people who are monitoring their behaviors all day could potentially increase their awareness and motivation to undertake healthier choices.

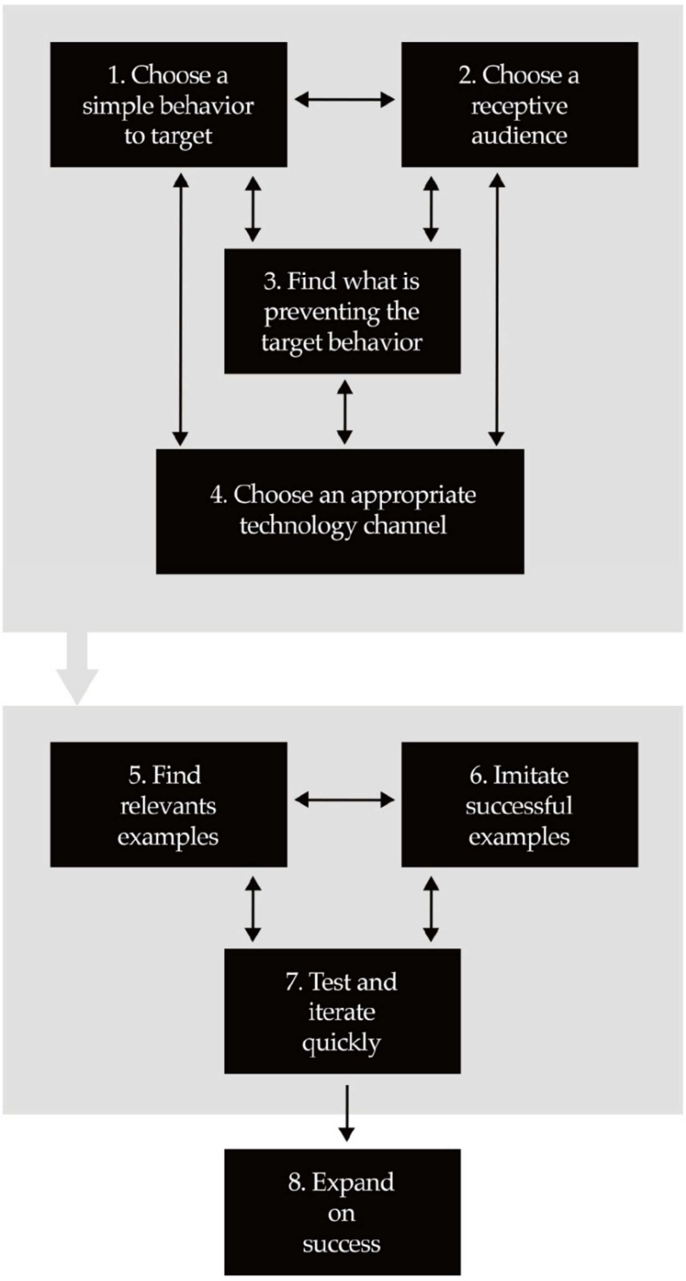


**Figure 4.1. Eight Steps in Early-Stage Persuasive Design**
Source: Fogg, 2009

Getting healthier and losing weight is a minute-by minute process. It is all about small choices one make throughout the day. It is easy for people to make bad, unhealthy choices even without being conscious of them, as we are in our world full of temptations such as, sugared sodas, fatty fried foods or high calorie snacks. People easily lose focus if they are not fully awake and aware what they are doing. Behavior monitoring is the first step in the process in achieving the larger goal—weight loss—as it is likely to cause cognitive activation of self-awareness of their commitment to being active and reminds people to make healthy choices.

### *Step 2: Choose a receptive audience*

Choose a specific user type that is most likely to adopt the target behavior rather than targeting all users. For instance, the design team in the early stages should first focus on those who have demonstrated a desire to change as opposed to those who have no intention to change behavior.

In order to prevent choosing the wrong audience and to increase the chances of success, I adopted Stage of Change Model (Prochaska, DiClemente, & Norcross, 1992) to identify my target user group. As Chapter 2 presented, the Stage of Change Model describes the five stages of change through which people progress to intentionally change and modify additive behaviors. The five stages are (1) precontemplation, (2) contemplation, (3) preparation, (4) action, and (5) maintenance.

Incorporating Fogg's second step design process into the Stage of Change Model, individuals in the precontemplation stage are excluded from my target group because precontemplators have no desire and intention to change their behaviors. Individuals in the maintenance stage are also excluded from my user group because behavior

monitoring— the target behavior for change— is the first step in the process in achieving weight loss, people who are already maintaining their weight do not need interventions that offer a frequent reminder about their commitment to being physically active. As well, they do not need interventions that remind them to make the right choices as they may have already become habits for them.

My target audience consists of individuals who have not taken action, or at least have not created a consistent behavior pattern yet, but have the ability and the motivation to incorporate physical activity into their daily lives. That is, individuals who are in the state of contemplation, preparation, and action stages of change as defined by the Stage of Change Model (Prochaska, DiClemente, & Norcross, 1992).

### *Step 3: Find what prevents the target behavior*

In this step, the designer must pinpoint why target users are not performing the desired behavior. What is preventing people from performing the behavior? A thorough examination at this stage is critical for determining propositions for effective persuasive technology solutions.

Since self-monitoring is such an important part of weight loss and preventing weight regain (Burke, Wang & Sevick, 2011; Raymond C. & Daniel S, 1993, and Kerri N. & Daniel S, 1998), the question arises as to why people stop self-monitoring. In terms of answering this question, I used Fogg's Behavior Model (FBM) (2009) as a guide to identify what stops people from performing a target behavior and what psychological element is lacking. The FBM (see Figure 4.2) states that a behavior is a result of three components that need to be present: (1) sufficient motivation, (2) an ability to perform the behavior, and (3) a trigger to perform the behavior. These three factors

must occur at the same moment; otherwise the behavior will not happen (Fogg, 2009). Did people stop self-monitoring because they are not motivated, or because of a lack of ability, or because they are not being triggered to do so at the right time? The reason can be a combination of the three factors. To answer these questions, all three major elements of Fogg's Behavior Model must be individually considered and analyzed.

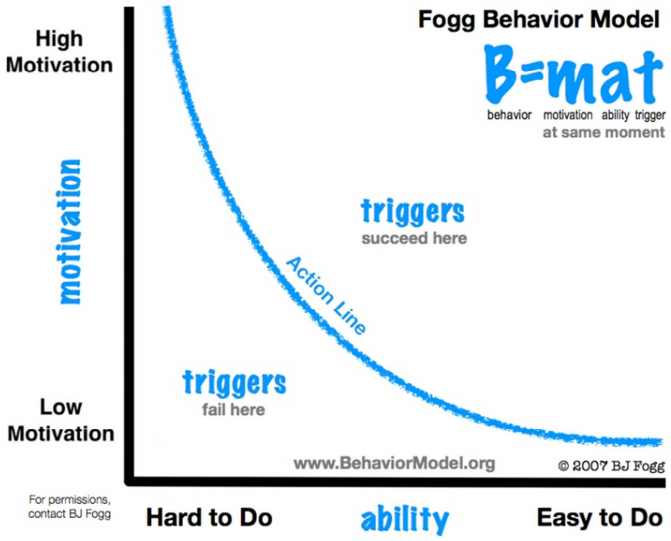


**Figure 4.2 The Fogg's Behavior Model.** Source: Fogg, 2009

### Motivation

Motivation defines the level of desire to take action. Dr. Edward Deci, professor of psychology at University of Rochester, defines motivation as "the energy for action." Individuals must ideally be motivated to perform the desired behavior, thus, boosting motivations may help them to change behaviors.

### Ability

Ability, as a major component in the Behavior Model, is largely emphasized by Fogg. Fogg instructs designers to focus on simplicity and ease of use. A successful

persuasive technology design must rely heavily on increasing users' ability to perform the target behavior and removing obstacles that stand in the way of their journey of behavior change, as "simplicity matters more than motivation" (Fogg, 2009).

### Trigger

A trigger works as any type of reminder, a call to action, or cue that prompts user to perform the target behavior (Fogg, 2009). For example a text message pop-up on the phone triggers the user to read and reply to that message, a growing stomach triggers the person to grab some food, and an alarming sound triggers the individual to pay extra attention. If the trigger happens when the individual is motivated and has the ability to perform the behavior, the desired behavior will occur.

After doing a literature review and interviews with people, I found that the reason why people stopped self-tracking were more complicated and emotion-based than I thought. Here are some possible reasons people are reluctant to self-monitor:

### Endless negative feedback loop

Today's programs and apps are recommending a thinking that defines "success" or "failure" based on numerical data. Data results have become the way people judge their own self-worth. When users see the numbers as they appear on their tracking device, they do not realize they are just numbers; they imagine it is a journal of either "success" or "failure." The tracking device acts like a critic that is always telling them they are failures and makes them feel guilty if they cannot reach their goals. As a result, people throw the trackers away simply because they do not want to feel bad anymore. As one person commented:

> *Each day my self-worth was tied to the data. One pound heavier this morning? You're fat. 2 g too much fat ingested? You're out of control. Skipped a day of running? You're lazy… I don't need data to tell me that (I am a failure), and I don't need to punish myself anymore… (I) won't let it be an instrument of self-torture anymore* (Quantified Self, Why I stopped tracking, 2010).

Other people also commented:

*"I have been self-tracking for a long time…Looking for patterns. Beating myself up when the numbers don't come out right… Feeling all the self-doubt, self-punishment, everything."*

*"Focusing on a numerical picture of oneself that can feel strenuous and constricting."*

From patients' comments, there appears a strong will to improve the means of monitoring and data presentation:

*"…it would be great to have psychological boosts along the way, like a therapy app that helps me process the judgment and meaning I ascribe to the numbers."*

*" I hope that some of us may be able to get the benefits of tracking, as you have, but avoid the pitfalls … maybe even coming up with new methods in doing so."*

*"With the dearth of detailed information self-tracking provides, one must develop a new type of data literacy."*

### Embarrassment

If weight management is a private matter for some of the people, frequent monitoring (especially if done in a public place) could possibly draw public attention as their checking actions may intentionally or unintentionally be seen by others. Users might find themselves reluctant to check regularly because they fear others would make unfair judgments about the fact that they are trying to lose weight. They also worry about their feelings being hurt by the friends and family members about unwanted conversation with weight management (Polonsky, 1999). Irresponsible advice and comments like “yeah, you know, this wouldn’t happen if you’d just develop some willpower” and “You are probably eating too much” will lead to bad feelings and finally cause the avoidance of self-tracking.

### Forgetting regular monitoring

Life becomes so fast, so busy, and so pressured that many people build a life around hard work. When people are drowning in a lot of work and deadlines, understandably, busy people just forget to monitor regularly.

Using Fogg’s Behavior Model, we can see that these three reasons for not self-monitoring, full within the lack of motivations and the lack of well-timed triggers.

According to Fogg, if a persuasive technology targets people who are lacking motivation, the design might focus on solutions for overcoming barriers or inspirational strategies in order to prompt motivation. For people who lack a well-timed trigger, the solution might focus on types of prompts, cues and calls to action.

### *Step 4: Choose a familiar technology channel*

Modern society has an increasing number of technology channels and mediums, thus choosing one out of all can be very challenging, yet important. In order to narrow down the choices, the design team should first consider "how well each channel matches the target behavior" and then must select a channel that is familiar to or already used by the target users, as adopting a new channel is like simultaneously adopting a new behavior which rarely works.

The term "technology channels" refers to "web, software installed on personal computers, mobile applications and texting on mobile phones, social platforms like Facebook, online video, platform games, and so on" (Fogg ,2009). To figure out which channels work best for my users in terms of physical activity behavior patterns monitoring, a comparison among current commercial monitoring technologies and the acceptance of these technologies is needed. Some current monitoring systems, such as *Jawbone, Fitbit* and *Misfit*, require additional sensing devices for individuals to carry, which could be troublesome and costly for deployment to a large user population. However, mobile phone-based physical activity recognition that uses phone based accelerometers to perform activity recognition, (Sun, Zhang & Li, 2011) which incorporated its own rich sensing power in existing phone platforms, requires no add-on devices and no extra cost to users (Kwapisz, Weiss & Moore, 2010 ). Currently, smartphones have enough computation power to calculate raw physical activity data generated by sensors into meaningful information for common users in milliseconds, which is accepted as real time. On the other hand, smartphone apps have added functionality that offers opportunities for data mining and visualization and the promotion of physical activity via tailored interventions.

In terms of usage habit, a report from Pricewaterhouse Coopers (2014) addressed 1,000 US consumers across all ages about wearable trackers use and adoption. Their data shows that 20% of American adults already own a wearable device. However, of those who own a wearable device, only 10% wear it every day. Compared with smartphone usage, approximately 64% of American adults now own a smartphone (Pew Research Center, 2015). Statistics also show a steady increase in the number of smartphone owners all over the world. As to the frequency that people check their phones, according to Locket's data, the average users check their phones over 110 times a day, with users unlocking their screens every six minutes (U.S Smart phone usage, 2015).

These findings suggest that, the always-carried and always-on nature of today's smartphone, as well as the availability of wireless connection, means that utilizing smartphones as a platform for long-term self-monitoring and activity capturing is promising. Users can reflect on their performance from the feedback generated from their phone and make modification and changes accordingly.

### *Step 5: Find relevant examples of persuasive technology*

This step requires doing extensive research on examples of successful persuasive technology that fit the chosen target behavior, users and channel.

Step 5 was already undertaken in the Chapter 3. Analyzing and evaluating relevant examples in Chapter 3, important lessons are learned for designing persuasive technologies to motivate and facilitate self-monitoring: use positive reinforcement to reward users who perform healthy behaviors, rather than using negative reinforcement to punish users who failed in performing; use understandable and

aesthetically pleasing visualizations to represent users' behaviors and goal attainment rather than using explicit numerical data; use a background display as a platform to offer frequent feedback in order to facilitate self-reflection; allow users to ignore the data while they are concentrating on other issues and designing for data abstraction in order to minimize the chances of drawing the unwanted attention of others; prompt the individual to engage with the technology and remain focused on commitment to physical activity; and provide experiences that maintain user interest by sustaining variability with use.

### *Step 6: Imitate successful examples*

In order to validate the behavior change strategies and the design concept quickly, Fogg claims that the sixth step is to imitate what is already working in terms of design process learned from successful examples.

In regard to behavior change, those who frequently self-monitor turn out to be more aware of their behavior, as it increases the chances of behavior reflection. A great number of researchers suggest that highly frequent and consistent self-monitoring, rather than occasional self-monitoring, can be crucial for effective weight loss and weight control (Boutelle & Kirschenbaum, 1998). However, such highly intensive self-monitoring behavior requires very frequent interaction with tracking devices along with possible visual, auditory, and multimodal displays that can be quite distracting and demanding for people, as information acquisition from visual or other kinds of displays requires attention, time and effort, even if it only takes a few seconds. Thus, to prevent users' negative feelings of being interrupted from their primary work, while making sure they still feel the presence of the information, it is very important

that the information visualization does not demand their full attention and only takes minimal time to extract information from a display.

Successful visual encoding can minimize the attention consumed in acquiring information (Vladimir, 2008). *Calm technology,* which was introduced to interface design by Mark Weiser and is now most familiar as *peripheral display* or *ambient display*, comes close to addressing this issue (Forlizzi, Li & Dey). Ambient display "moves information from the periphery to the center of human attention and back," the goal of which is presenting information in a way that users can easily yet quickly understand and at the same time sustaining for peripheral awareness capabilities—people are in the presence of the information without any negative feelings.

In the following, Matthews, Forlizzi, and Rohrbach's 'Glanceable Display Design Principles' (2006) along with a set of strategies established by Consolvo (2008) are introduced to inform the design of an ambient display to support behavior change. The five most relevant design strategies of Consolvo are chosen for this thesis and a new strategy proposed by the author as an extension of these is also described.

### Glanceable Display Design Principles

Matthews, Forlizzi, and Rohrbach define "glanceable" as information displayed in a manner which allows users who only take a glance to extract information from a display with low cognitive effort. It focuses on rapid interpretation of information once information is presented. They assert that a display's glanceability is especially essential in designing an ambient display that requires users to receive information frequently. The more the user has to receive, the more likely it is that the user feels interrupted and the greater

mental effort is required, resulting in a less effective display. However, if the display is easy to access and only takes a glance to be understood, frequent information reception will no longer be a problem as the user can still focus on their primary task without being overwhelmed by the information.

The Glanceable Display Design Principles are used to accomplish the design of a highly glanceable visual display. The Glanceable Display Design Principles are as follows:

- **Match user expectations**

Visual representations should be closely linked with the information they convey and contain meaning which the user is able to quickly interpret. Researchers found that semantically meaningful images that enable the understanding of an entire idea, concept, or sentence will improve glanceable comprehension.

- **Use abstraction representations**

Information should be represented abstractly as it reduces the number of details that need to be consumed. Researchers found that abstract visuals, such as represented images, were quite effective in their studies. In terms of data visualization, using data abstraction representations rather than explicit numerical displays were also considered effective in information communication.

- **Make visuals distinct**

Visuals need to be distinct and identifiable from each other if they are meant to convey many levels of information. Distinct visuals also improve the

identification of important or new information so that people can quickly interpret it at a glance.

- **Maintain consistency**

If the design elements are meant to represent similar information, they should be kept consistent whenever possible. Otherwise, inconsistent visual representations can cause confusion; for example, a magnifying glass in some interfaces means “zoom in,” but sometimes it also stands for a search engine. Designers must avoid using more than one meaning in the same context. Consistency also enhances the familiarity with the system, in turn minimizing the amount of time viewers need to perceive and process the information.

## Consolvo’s Eight Design Strategies

Consolvo’s ‘Eight Design Strategies’ are intended to be used to inform the design of a persuasive technology to support an individual’s desire of healthy behavior change. Different from the Glanceable Display Design Principles that only concentrate on peripheral display designs, Cosolvo’s strategies have a broader application to the approach of behavior change. The strategies are drawn from both behavioral psychology and social psychological theories and specifically account for social characteristics throughout daily use. The usefulness of these strategies has been demonstrated by a successful 3-month trial in testing the persuasive system—*UbiFit*—built upon these strategies.

The five most relevant design strategies—abstract & reflective, unobtrusive, public, aesthetic, and positive—are selected and explained in detail as they closely guided and informed the design of RunDrawing. The remaining design

strategies—controllable, trending/ historical, and comprehensive—have fewer applications to RunDrawing as they focus primarily on technical development of the system.

- **Abstract & Reflective**

Very similar to the third design principle of Matthews, Forlizzi, and Rohrbach, Consolvo also asserts the importance of using abstract visualizations. Specifically, she emphasized the importance of using data abstraction representations rather than just raw or explicit data collected directly from technologies to display information of users' behavior and goal attainment.

Abstracted data not only facilitates effective information comprehension (the third point of Glanceable Display Design Principles); by its characteristic of ambiguity, it also allows users to "create alternative explanations of the data should it intentionally or otherwise be seen by another—that is, it provides the ambiguity necessary to create a story"(Consolvo, p.69, 2008). In addition to no raw data being displayed to demand the cognitive efforts of users, abstract visualization also allows users to ignore the information, but still provides enough detail to facilitate self-reflection of their behavior when they want to.

The strategy of using abstraction to represent behavioral data was employed by *Fish'n' Step* with happy faced fish representing sufficient physical activity levels and sad faced fish representing a lack of behavior. It is also employed by *Forest* App with each tree representing 30 minutes of concentrating, and by *Shakra* with different cartoons representing different behavior status. *UbiFit Garden* also uses virtual flowers and butterflies to represent different activities and goal attainments.

- **Unobtrusive**

Data should be presented in an unobtrusive manner without demanding immediate attention from users. Furthermore, information should always be present and easy to access whenever users need it.

Notification displays, such as text message alerts, pop-ups, or ring tones are all attention capturing which could draw unwanted or unnecessary attention to the user. Products aiming at consistent self-monitoring behavior adoption should avoid using attention capturing technologies too much. In the case of *Forest* App, the system sends push notifications when users' trees are fully grown to indicate that it is time to plant a new tree. However, users found it annoying because the app interrupted them from their primary task at hand. There is a need for the system to automatically plant new trees when required. *Shakra* and *UbiFit Garden* are two successful examples which unobtrusively integrated into users' daily lives, displaying information quietly and also making information available whenever the user requests it.

- **Public**

Data should be presented in a manner that users will feel comfortable showing when in the presence of others. Since data needs to be available whenever and wherever users need it, other people may unintentionally notice it. In this case, data representation should cater to users' feeling and make users comfortable in these situations (ties back to social norms construct in the Theory of Reasoned Action and Theory of Planned Behavior).

Regular Self-monitoring requires personal checking and tracking which may increase the chances of such action being noticed by others. Effective behavior

monitoring requires consistent and multiple checking times throughout everyday life. It is very important that data representation is displayed in a way that does not draw the unwanted attention of others and can be presented in front of others without making the user feel uncomfortable.

- **Aesthetic**

"If the display and any accompanying devices function as a personal objects," they need to be "attractive to support the user's personal lifestyle" (Consolvo, p. 68, 2008,).

Several studies (Mbipom & Harper, 2009; Tractinsky, Katz & Ikar, 2000; and Nielsen, 1994) have drawn the conclusion that from users' perspective "what is beautiful is usable." People draw on aesthetic factors to judge usability, but credibility as well. Fogg et al. (2003) found that almost half of users made judgments about the credibility of the websites based on interface design factors: layouts, typography, font size and colors.

The success in *Forest* App is largely depended on the aesthetically pleasing visualization it provides. Although the *Forest* App is in its development phase, with many imperfections, its cute and creative design connects users' emotional attachment to it, making the app difficult to abandon. *Fish'n' Steps*'s interesting fish tank display also successfully drew initial excitement from other people who were not participating in the study and peaked their interest in trying the application.

- **Positive**

Positive reinforcement rather than punishment should be used to encourage behavior change. Rewarding the user for performing the desired behavior may help to increase users' performance and to activate positive feelings, while using punishment for failing to perform the desired behavior may trigger negative feelings such as dissatisfaction and guilt, which in turn hurts self-efficacy and lowers commitment.

Consolvo highlighted situations that behavior change products should be concerned with. People may get sick, injured, or have a tight deadline at work that reasonably prevents them from sustaining the desired behavior. At such times, behavior products that are not flexible enough to accommodate users' basic needs could make users feel discouraged and result in the product being abandoned.

The projects and applications mentioned in the previous chapter all focus on rewarding good behaviors. *Fish'n' Steps* provides fish along with different tank decorations for rewarding sufficient physical activity levels. *Forest* app provides virtual trees along with a flourishing forest view (if one resists the temptation of using the phone). *ActivMON* applies color psychology to motivate desired healthy behaviors, "green is good, red is bad," and *UbiFit Garden* provides a blooming garden if users commit to their health goals. However, only *UbiFit Garden* focuses on providing positive reinforcement rather than punishment. The remaining all provide certain levels of punishment: in *Forest* App, if people failed to sustain the desired behavior for the requested time, they will get a withered tree as punishment. Notably, the use of punishment in *Fish'n' Steps*—the sad fish, the disappearance of tank

decorations, and the muddy water—all result in reduced use or even abandonment of the product.

### An additional Proposed Design Strategy

The above design strategies proposed by Consolvo are intended to be used to inform the design of persuasive technologies in order to encourage healthy behavior change. Among these strategies, five of them significantly impacted and guided the design of RunDrawing. An additional design strategy is proposed, as an extension of these five strategies, by the incorporation of the theories and related work described in Chapters 2 and 3. This additional design strategy is called

- **Variable Rewards**

To prevent the initial fascination from fading away, an element of mystery is an important component in sustaining users' interest. The persuasive system should constantly deliver new features and experiences to cater to an individual's desire for novelty.

What was learned from *Fish'n' Steps*, *Forest*, *Shakra*, *ActivMON* and *UbiFit* is that the experience gradually became less engaging as the variety of what is offered is limited. A system that is intended to maintain user interest for the long term should provide hard-to-predict features and content to "wow" its user.

### *Step 7: Test and iterate quickly*

The seventh step of Fogg's 'Eight-Step Design Process' is to test various persuasive experiences quickly and repeatedly. The design team should focus on a series of small and rapid tests rather than one big test because a small test will allow them to prototype the experience easily and get quick responses from people.

The approach introduced in this step will be used and discussed further in Chapter 6—The Evaluation of RunDrawing.

### *Step 8: Expand on success*

The eighth step is to expand or scale up the success once the persuasive technology concept is proven to be effective at changing the target behavior.

Because of time constraints, a fully functional system-based prototype which runs on a mobile device for testing is beyond the scope of this thesis.

## 4.2 Chapter 4 Summary

In this chapter, Fogg's 'Eight-Step Design Process' is adapted to guide the early stage formation of RunDrawing. The design processes were then expanded by Matthews, Forlizzi, and Rohrbach's 'Glanceable Display Design Principles' (2006) along with a set of strategies established by Consolvo (2008). A new strategy proposed to perfect Consolvo's strategies is also introduced. The newly developed strategy is based on theories and related works as described in Chapter 2 and 3.

In the next chapter, the ambient display that was developed for this thesis, RunDrawing, is presented. A detailed design concept is described, followed by a discussion of how the design decision making and design process for the development of RunDrawing were largely influenced by the above design principles and design strategies.

# Chapter 5
# THE RUNDRAWING SYSTEM

Previous chapters have discussed the following: three behavioral theories that are relevant to the design of persuasive technologies to encourage behavior change; empirical studies and projects that have developed persuasive technology to promote behavior change; and sets of design strategies and principles to inform and guide the design of persuasive technologies. In this chapter, the persuasive technology to motivate people struggling with obesity to live a more physically active lifestyle is presented. RunDrawing (see Figure 5) is designed for people living with obesity and individuals who have not taken action, or at least have not created a consistent behavior pattern yet, but have the ability and the motivation to incorporate physical activity into daily lives, that is, RunDrawing's target users are individuals who are in the state of contemplation, preparation, and action stages of change as defined by the Stage of Change Model (Prochaska, DiClemente, & Norcross, 1992) described in detail in Chapter 2.

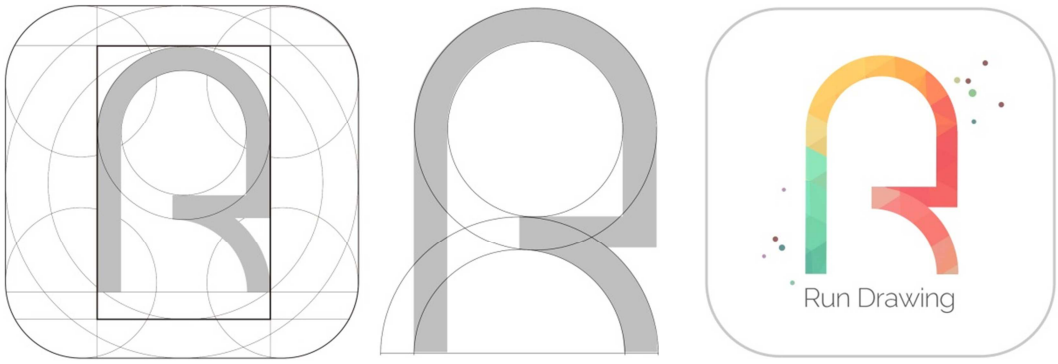


**Figure 5 Images for RunDrawing's icon Design.** From left to right: RunDrawing's icon grid system; RunDrawing's icon design system; RunDrawing's icon rendering.

RunDrawing consists of two main components: (1) a lock screen background display and (2) an interactive gallery. The *lock screen background display* incorporates *calm technology* which uses a stylized and aesthetically pleasing information visualization of behavior and goal attainment to promote healthy behavior. The interactive gallery collects drawings from individuals' physical activity and allows their autonomy to manually edit, delete, and share their "running drawings" if they want to. The RunDrawing system uses a phone-based sensor to calculate and infer physical activity data to the lock screen background display in real time. Each of the two main components of RunDrawing is presented, followed by a discussion of how the design strategies and principles described in Chapter 4 largely guided and influenced the design of RunDrawing.

## 5.1 RunDrawing's Lock Screen Background Display

The RunDrawing's *lock screen background display* uses a non-literal but understandable and aesthetically pleasing format drawing as a metaphor to represent key information in real time about individuals' physical activity behavior and goal attainment. RunDrawing's display is intended to reside on the lock screen background of the individual's mobile phone so that every time the individual uses the phone, for example to check time, to reply to text messages, or to make a phone call, he/she also can see the background as feedback about his/her physical activity and goal attainment.

In this thesis project, the display was implemented on the lock screen background of individuals' mobile phone (see Figure 5.1.1). Individuals are subtly reminded of their behavior pattern any time and anywhere they use the phone. The stylized and

understandable display fulfills the criterion of “glanceability” postulated by Matthews, Forlizzi and Rohrbach (described in Chapter 4), that is, through a glance at the background screen, individuals can rapidly interpret and understand information relating to their physical activity behavior. Considering the high frequency of mobile phone usage (average 160 times per day), individuals should reflect on the display often enough to fulfill the requirement of “highly frequent and consistent self-monitoring rather than just some self-monitoring” for the reminder of their commitment to being active. The display itself can exist in a visual environment without drawing unnecessary attention of other people, as it is common for people to use and change their background wall papers.


**Figure 5.1.1 RunDrawing’s lock screen background display.** It uses a non-literal but understandable and aesthetically pleasing format drawing as a metaphor to represent key information in real time about the individual’s physical activity behavior and goal attainment

The version of RunDrawing display that was designed for this thesis project uses an abstract drawing as a format of graphic feedback that smoothly changes throughout the week as the individual performs physical activity (see Figure 5.1.2). The graphic

feedback will be generated in real-time during the on-going activity performed by the individual and represented as an abstract drawing created by him/her. The individual's mobile phone starts as a white canvas on the lock screen. As the individual performs the physical activity it begins drawing on the white canvas in accordance with information related to body movements. The system continually and automatically changes sizes of brushes along with colors to draw according to the efforts of the individual and the time spent on their workout. The longer the time the individual does the physical activity and the harder he/she tries, the richer the color and the more detail will be present in the drawing. The individual is able to unlock different effects while he/she is doing different variations of activities, for example running/cycling/walking. When the individual meets his/her weekly goal, his/her signature and a pre-determined inspirational message will appear near the lower right corner of the display.


**Figure 5.1.2** RunDrawing's *lock screen background display* will smoothly change throughout the week as the individual performs the physical activity.


**Figure 5.1.2** RunDrawing's *lock screen background display* will smoothly change throughout the week as the individual performs physical activity. When users meet their weekly goal, their signature and a pre-defined inspirational message will appear near the lower right corner of the display. A matured and richly detailed drawing represents healthy behavior.

The abstract drawing display consists of three changing stages: vacant, solid and booming. The different stages of the drawing represent different levels of individuals' weekly goal attainment. Within stage one—vacant—the system automatically chooses the thickest brush tips to cover the canvas (see Figure 5.1.3). Large color blocks appear on the canvas as individuals perform the physical activity. If individuals stay at the vacant stage, this means that they are still far away from their weekly goal attainment with less than 30% of their goal achieved. By the time the canvas is fully covered by big color blocks, the drawing moves into stage two—solid (see Figure 5.1.4). Within this stage, the system changes the brush tips from largest to medium, which allows more refined details and textures to be drawn. Individuals can then apply self-control by examining their behavior status (physically active or inactive) based on how many details and colors combinations have been generated and making changes accordingly. When the system picks the finest brush tip to continually draw with, there will be finer details as the user moves further into the last stage—the booming

stage (see Figure 5.1.5). Once the drawing gets into this booming stage, about 80% of individuals' weekly goal has been reached. Individuals can recognize whether they are active or inactive by observing changes in drawing details (see Figure 5.1.6) With RunDrawing's *lock screen background display*, a matured and richly detailed drawing represents healthy behavior. With a glance at the drawing, individuals should easily be able to comprehend the visual representation and quickly reflect on whether they are having a generally active or inactive week.

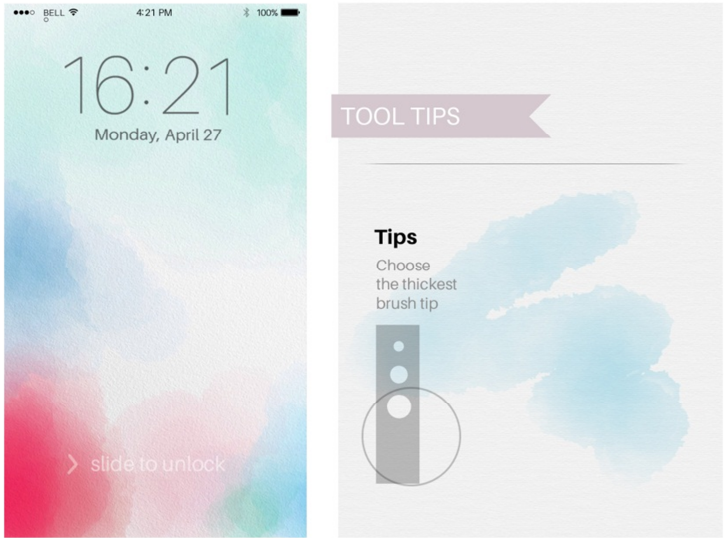


**Figure 5.1.3 Images for "vacant" drawing stage.** Large color blocks appear on the screen as individuals perform the physical activity.

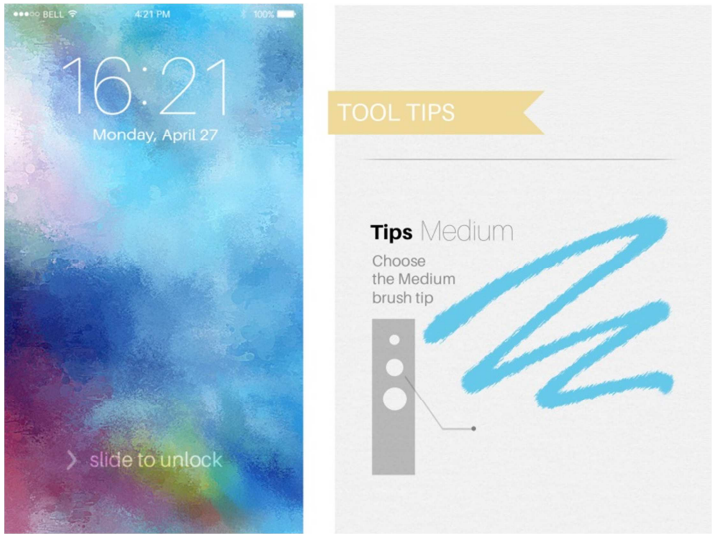


**Figure 5.1.4 Images for "solid" drawing stage.** More refined details and textures will appear on the mobile phone background screen.

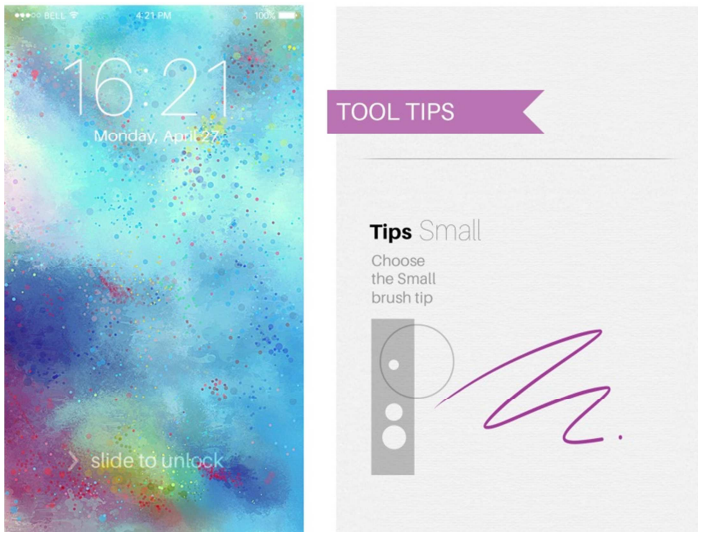


**Figure 5.1.5 Images for "booming" drawing stage.** When massive details appear, indicating that the drawing moves further into the last stage with 80% of users'weekly goal reached.


**Figure 5.1.6 Image for RunDrawing's data abstraction visualization.** More details and color combinations represent more intensive physical activity during the day. With a glance, individuals can recognize whether they are active or inactive by observing changes in drawing details.

RunDrawing applies positive reinforcement. Even if individuals are having an inactive week, or day, they will not be confronted with a blank screen or a negative dark color spot. The screen will simply stay in the first vacant stage with few color blocks on the background. The RunDrawing's *lock screen background display* described above resets to an empty white canvas each week at 12:00 midnight on Sunday, allowing individuals to start over fresh in the coming week.

As suggested before, RunDrawing uses data abstraction representations to convey key information about individuals' behavior and their goal attainment. Through a glance at the display, individuals can rapidly interpret how far they are from in reaching their weekly goals without looking at numerical data visualizations. However, RunDrawing still supports individuals' need of digging deeper about their physical activity information using charts and numbers. Individuals can switch to this view which uses numerical data to present accurate behavior information for the day or activity trends during the week (see Figure 5.1.7). In order to prevent inaccurate records of the physical activity, this system also allows individuals to add, edit, and delete inferred data. Individuals can also track their food intake and manage their weight using this interface (see Figure 5.1.8).

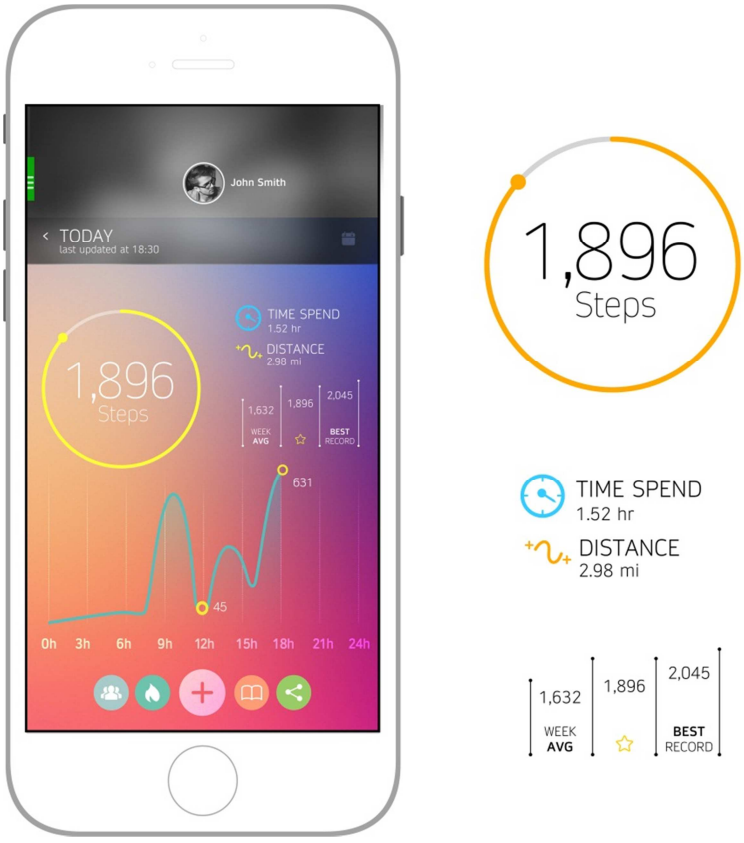


**Figure 5.1.7 Images for RunDrawing's numerical data visualization.**
Individuals can switch to this view for more accurate and explicate behavior information that presented by numbers and charts.


**Figure 5.1.8 Images for RunDrawing's numerical data visualization (transition)** Individuals can track their food intake and manage their weight by clicking the corresponding Button.

RunDrawing is designed to be used long term and should sustain an individual's interest and support his/her personal style. In order to prevent the initial engagement from fading away, an element of mystery is an important component of RunDrawing. By offering surprises and new experiences, it caters to an individual's desire for novelty (tied back to variable rewards described in Chapter 4).

Other conceptual ideas besides the abstract drawing theme were also explored, for example, landscape (see Figure 5.1.9), and flowers (see Figure 5.1.10). Holiday themes would be also available throughout the year. For example a Halloween theme would use intensive black and orange as dominant colors, and white color as accent color to perform the drawing along with spider net displays on that particular day.

A Christmas theme would use red, green and white as main colors along with blue, gold and silver as accent colors with a snowflake display for the 25th of December. These design concepts not only attempt to address issues of individuality, gender and taste but are also designed to intentionally mix new content and experiences for the "wow" factors for its users.

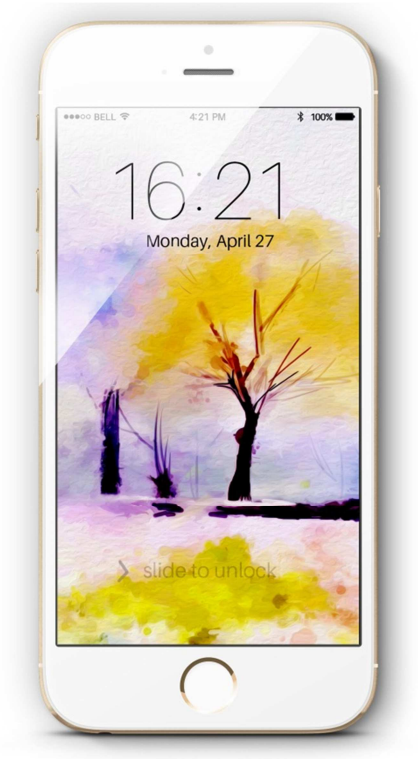


**Figure 5.1.9 Image for LandScape Theme**

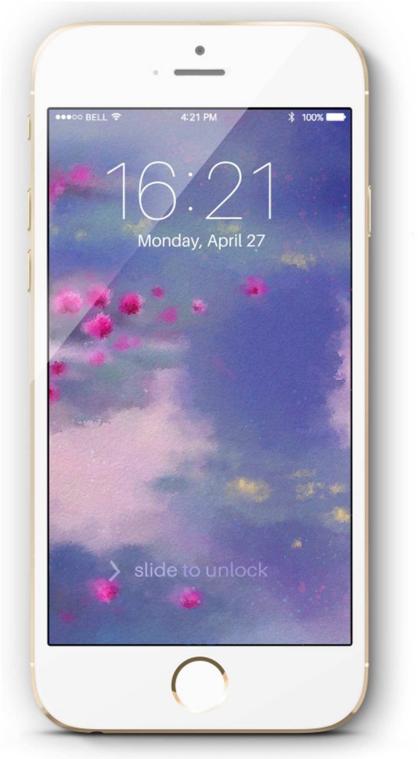


**Figure 5.1.10. Image for Flower Theme**

## 5.2 RunDrawing's Interactive Gallery

The *interactive gallery*, which has been implemented on an individual's RunDrawing app, collects all an individual's "running drawings." With the *interactive gallery*, the individual can do the following:

1. View a daily drawing of physical activities an individual has done for today and any prior week's drawing since using RunDrawing within a "gallery view" (see Figure 5.2.1).

2. Switch to another view, the "grid view" (see Figure 5.2.2), where the individual can compare all the drawings as opposed to a single picture in "gallery view."

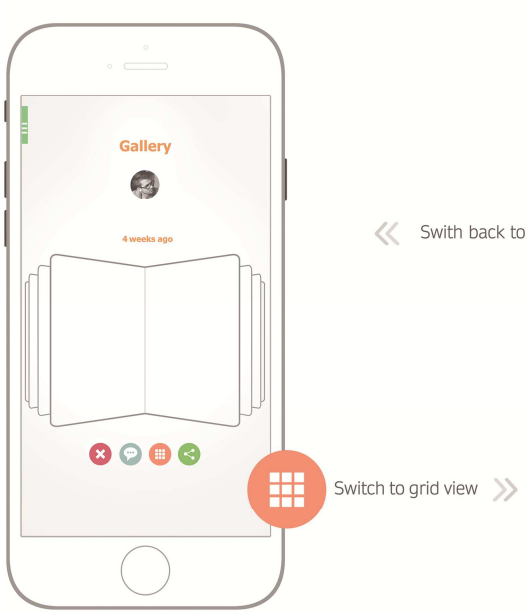


**Figure 5.2.1 Image for the "gallery view" of RunDrawing's interactive gallery.** Individuals can flip through the gallery and track back history of their performance using "running drawings."

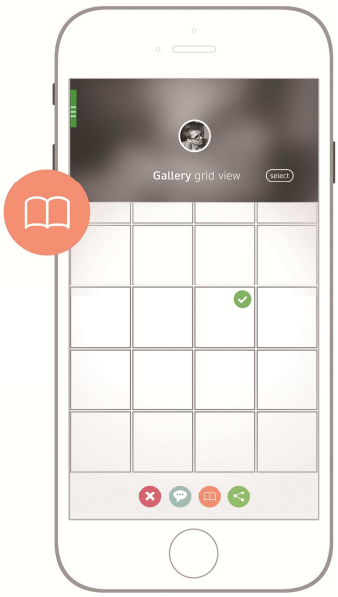


**Figure 5.2.2 Image for the "grid view"** Individuals can compare all their "running drawings" as opposed to a single picture in "gallery view."

3. Manually delete, view and share drawings.

- RunDrawing allows an individual to view his/her drawing changes during the week by showing an animated graphic. The animated graphic extracts drawings from each stage accordingly, from vacant to booming and then combines them into a one second clip (see Figure 5.2.3).

- The individual would be able to delete any drawing that he/she does not want to keep in the gallery.

- By clicking on the share button, the individual would be able to share either the short video clip of his/her drawing in changes or a still drawing to a variety of social media, such as Facebook, Twitter, or Instagram (see Figure 5.2.4).


**Figure 5.2.3 Image for animated graphic layers**
The animated graphic extracts drawings from each stage accordingly, from vacant to booming and then combines them into a one second clip

With this *interactive gallery*, the hope is that individuals can direct their attention away from raw weight loss numbers, at the same time value their efforts during the creation process of their weight loss journey, as a way of gaining qualitative insights and meaning. Just as William Bruce Cameron once said, “Not everything that can be counted counts; not everything that counts can be counted” (Cameron, 1963).

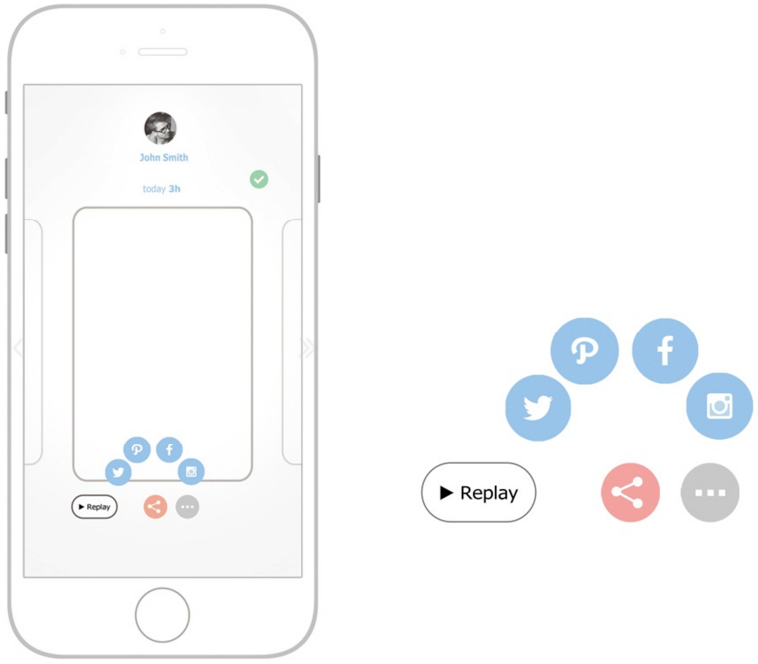


**Figure 5.2.4 Images for sharing "running drawings"**
Individuals would able to share either the short video clip of their drawings in changes or still drawings to a variety of Social Media.

## 5.3 Implementing the Design Principles and Strategies in RunDrawing

In chapter 4, design principles and strategies were introduced for guiding and designing persuasive technologies, which included the following: Glanceable Display Design Principles, Consolvo's design strategies, and a newly proposed strategy that added to Consolvo's design strategies. RunDrawing utilized all these design principles and strategies, as follows:

## *Glanceable Display Design Principles*

- **Match user expectations**

  The RunDrawing's *lock screen background display* uses an abstract drawing to visualize and represent information about individuals' physical activity behavior and goal attainment. The different stages of the drawing are closely linked with individuals' goal attainment progress and their behavior status. RunDrawing's stylized visual representation is semantically meaningful and 'glanceable': by glancing at the display, individuals can interpret if they are having an inactive or active week based on stages of the drawing and its level of complexity.

- **Use abstraction representations**

  The RunDrawing's display uses a non-literal format drawing as a metaphor rather than using explicit data or numerical representations which most commercially available apps are adopting to represent key information about the individual's physical activity behavior and goal attainment. Meanwhile, the data abstraction—the drawing—provides frequent and subtle reminders of an individual's commitment to being physically active. Due to its nature of ambiguity, it also allows the individual to explain the drawing display in many ways; for example the individual can explain the display as a dynamic wallpaper set on his/her phone.

- **Make visuals distinct**

  The RunDrawing's abstract drawing display consists of three changing stages which includes vacant, solid, and booming. The system automatically chooses different sizes of brush tips to draw with (progressively from the thickest to the finest) which gives distinct and recognizable changes in visual effects to represent

different levels of progress of an individual's weekly goal attainment. Once the system picks a different brush tip to draw with, the individual should be able to identify its changes easily and self-reflect upon that. When an individual's self-determined weekly goal is achieved, his/her signature appears on the bottom right corner as a reward and indication of goal attainment. Every stage of change in the drawing conveys a level in a hierarchy of behavioral information that is critical but understandable for the individual. These changes are distinct and identifiable from each other which supports quick interpretation at a glance.

- **Maintain consistency**

  In spite of RunDrawing's display of various for different drawing themes (landscape, flower, and holiday specialties), the functionality stays the same and consistent. Imitating real life painting technology strategies, RunDrawing's system starts with large color blocks to fill the background canvas, and then progressively moves into stage two with a medium brush size, and the last stage uses the finest brush tip to draw the most finest of details. Based on the process described above, it is not likely that the drawing will lose its structure and logic to cause confusion and misunderstanding in the users; instead, it offers infinite possibilities to create variations of visuals.

### *Consolvo's Design Strategies*

- **Abstract & Reflective**

  This design strategy is very similar to the second point of Glanceable Display Design Principles—use abstraction representations—which has been discussed previously.

- **Unobtrusive**

  RunDrawing's display resides on the lock screen background of individuals' mobile phone where it conveys key information about their behavior and goal attainment. It collects and presents information in an unobtrusive manner without demanding immediate attention, for example ring tone or message alerts, as they may distract individuals from their primary work. Due to the popularity and frequent use of mobile phone, individuals should see their phone's background frequently. Because the drawing is visible each time they use the phone, individuals should have frequent feedback about their behavior. This exposure is more likely to cause cognitive activation of self-awareness of their commitment without coercion. More importantly, because of its characteristic of unobtrusiveness, it allows for the situations when individuals need to ignore the information.

- **Public**

  As discussed in Chapter 4, one of the reasons people stop self-monitoring may be because of embarrassment. For some people, weight management is a private matter. Frequent monitoring (especially if done in a public place) could possibly draw attention to their screens and may intentionally or unintentionally be seen by others. The use of abstract drawing as a way to visualize physical activity information of individuals' supports the social implication which allows them to explain the display as a dynamic wall paper.

- **Aesthetic**

  Similar to clothing, a projected manifestation of who we are as individuals and who we want to be perceived as, mobile phone background screens are also used to represent identity and for self-expression. People frequently change their

background wallpaper for aesthetic reasons. Thus, RunDrawing's display not only has been designed as something that an individual would like to set as their wall paper, but it functions to convey and represent behavior information of an individual for self-reflection. Different themes of the drawings are also intended to cater to personal tastes.

- **Positive**

  RunDrawing uses positive reinforcement rather than punishment to motivate healthy behavior change. As an individual performs an activity, colors appear on the white canvas of an individual's personal mobile screen according to information related to body movements. In the RunDrawing system, the harder the individual works the more matured and complex the drawing results become compared to individuals who exert less effort. Those who only achieve a small portion of the weekly goal would still get something of beauty appearing on the screen, just without more drawing details. The individual also gets a fresh start each week when the screen resets to an empty canvas, so even if he/she had a bad week, he/she can start over in the coming week.

### *Newly Proposed Design Strategy*

- **Variable Rewards**

  RunDrawing's system supports its unique way of inferring raw physical activity data into meaningful graphics and drawings; that is, the system randomly chooses color combinations and locations to draw. Due to its random nature, it offers infinite possibilities to create variable forms of art. Even though every day activity is the same, every drawing will not be the same. Different people create differently because everyone's physical activity behavior pattern is different.

RunDrawing iterations also explored and included display possibilities other than abstract art, for example, landscape, flowers and specialty holiday themes, the aim of which is to offer new surprises and experiences and to prevent the initial fascination with the experience from fading away, but also to sustain an individual's interest by supporting his/her personal style and taste.

## 5.4 Chapter 5 Summary

In this Chapter, the version of RunDrawing that was designed for this thesis porject was described. The two main components of the RunDrawing were introduced: (1) the lock screen background display, and (2) the interactive gallery. The *lock screen background display* incorporated calm technology that uses a stylized and aesthetically pleasing information visualization of behavior and goal attainment to promote healthy behavior. The *interactive gallery* collects images of individuals' physical activity where they can delete, view, and share their drawings. A discussion of how the design strategies and principles described in Chapter 4 guided and influenced the design of RunDrawing was also presented.

# Chapter 6

# EVALUATION OF RUNDRAWING

In the previous chapter, the RunDrawing system that was designed for this thesis project to motivate individuals to live a more physically active lifestyle, was presented. In order to evaluate whether RunDrawing is able to improve individuals' awareness of physical activity and whether it has potential in facilitating positive emotional coping throughout everyday use, participants were recruited to evaluate the RunDrawing concept. A qualitative analysis was used to assess RunDrawing. This qualitative evaluation focused on findings from both the in-depth interviews and the focus group study and uses representative quotations to describe the perspectives of respondents in their own words.

This chapter covers the following aspects: study participants, details about data collection methods, and the overall reactions to the RunDrawing concept. Participants' reactions to the main components of the RunDrawing system—the *lock screen background display* and the *interactive gallery*, are discussed specifically to address the understanding of the participants' perceived effectiveness of these components, and how important they are to the RunDrawing system. This chapter ends with a discussion of participants' responses to RunDrawing that relate to and support the design strategies and principles introduced from Chapter 4.

## 6.1 Methodology

### *6.1.1 In-depth Semi-structured Interview*

The in-depth semi-structured interviews covered a range of questions about participants' attitudes and experiences with commercially available weight loss/control apps, as well as their physical activity patterns. To generate feedback on proposed RunDrawing concept, participants were asked to speculate about using RunDrawing like any commercial app.

A mix of closed-ended questions (multiple choice) and open-ended questions were asked about the concept of the RunDrawing's display, participants' physical activity behavior, and their experiences and attitudes of using commercial weight loss/control apps. Those questions that focused on soliciting feedback about the graphic design for the display helped further develop and improve the initial RunDrawing concept. In addition to questions related to design response, the semi-structured interviews also collected information about participants' demographics and their familiarity with technology.

Participants engaged in two telephone interview sessions that were conducted with one participant at a time. Participants were individuals living with obesity and were recruited from the Canadian Obesity Network. Two interviews were completed in 20-30 minutes depending on responses provided to the questions. Recruitment was done via email, with two participants—one from Toronto, the other from Edmonton who showed interest in participating. They received the proposed RunDrawing

concept by email one week ahead using a slide show (PowerPoint) and were asked to look through the concept before the interview date.

### Study Details and Study Participants (N=2)

The telephone-based in-depth semi-structured interviews were administered in May 2015. Two patients (both female) participated in the interviews. Participants were aged 32 and 52 and lived in Edmonton and Toronto, respectively. Both participants were employed full-time, one worked as an Educational Assistant, the other worked for Habitat for Humanity. One of the participants had had successfully lost a significant amount of weight and had been maintaining her weight for more than three years. According to Stages of Change Model (Prochaska, DiClemente, & Norcross, 1992), she was at the maintenance stage. The other participant had had bariatric surgery which helped her lose a certain amount of weight and since then she was taking action to incorporate regular physical activity and good eating habits into her everyday life. Defined by Stages of Change Model (Prochaska, DiClemente, & Norcross, 1992), she was at the stage of action. The participant who was at the stage of maintenance had considerable experience using mobile weight loss/control apps while the other participant, who was at action stage, had little experience with specific weight loss/control apps, but she did use a step counter to help her stay focused on being active. Each of them participated in the telephone interviews individually, which were audio recorded and transcribed.

The semi-structured interview included a mix of closed-ended and open-ended questions. Eight of the questions were open-ended questions about the RunDrawing concept that asked for general feedback. The open-ended questions were:

- How do you feel this design (the RunDrawing concept) would provide you with a meaningful experience?
- Do you find it (the RunDrawing design concept) in some way pleasurable and fun? What aspects make you feel that way?
- Do you think the background display is able to affect your physical activity awareness and behavior? Why?
- How well does the dynamic abstract drawing provide an understandable representation of your goal attainment?
- Besides all themes mentioned, abstract art, landscape and flowers, are there any others that you think would interest you?
- What do you like about the idea?
- What do you dislike about the idea?
- Please include any feedback you have on how the design can be improved to be more appropriate for you.

Each of the participants responded in detail to the questions listed above. General reactions and feedback to the RunDrawing concept are provided in the next section, with a highlighting of responses that suggesting other types of graphic design for RunDrawing's display.

### Overall Reactions to the RunDrawing Concept

Not surprisingly, the participant who was at the maintenance stage as identified by Stage of Change Theory did not like the RunDrawing concept, whiles the other participant who was at the action stage was very positive about the concept of RunDrawing, despite the fact that she did not usually carry her phone while working

out. The negative responses given from the participant as a “maintainer” were to be expected. As described in Chapter 4, individuals who are at maintenance stage are excluded from my target user group, given the fact that they usually have different design requirements as well as specifications from the product I am proposing. As mentioned in Chapter 4:

> *Individuals in the maintenance stage are excluded from my user group. As behavior monitoring— the target behavior for change— is the first step in the process in achieving weight loss, people who are already maintaining their weight do not need interventions that offer a frequent reminder about their commitment to being physically active; as well, they do not need interventions that remind them to make the right choices as they may have already become habits for them.*

The participant commented about RunDrawing’s concept not fully supported her specific needs as a maintainer. As habits of regular physical activity and healthy eating had already established and successfully integrated into her everyday life, RunDrawing’s purpose in encouraging positive emotional coping, boosting motivation and offering constant reminders of her commitment to be active became noise for her. She needed a system able to provide her explicit behavior information to help her look for patterns. Comments from her:

> *I am trying to think if it (RunDrawing concept) would work for me and I don’t think it would. Because, the way I function, very accurately, record my calories, so people who are, perhaps, really watching their calories, would never use the abstract screen as opposed to the actual number screen.*

Another reason that she was not interested in RunDrawing was because she had a background of studying Fine Arts. Paintings, especially abstract paintings were all about what she learned and practiced in university:

*"I did this (abstract painting) a lot. I am an artist. So abstract is my thing…I just feel like it (the abstract drawing display) doesn't connect me enough with an interest."*

It is interesting to note that, despite the fact that she thought RunDrawing might not work for her, she claimed she could imagine it being used by someone she knew.

Very positive feedback was received from the second participant (at the action stage). She commented on how she liked the "glanceable" (Matthews, Forlizzi & Rohrbach, 2006) nature of the abstract data visualization. Words such as *"really cool"* and *"very cool"* were frequently used during the semi-structured interview:

*"I think that is a very cool concept, especially for person as a visual. It is very good to show how they are doing."*

*"I like the idea of how it works as a personal reminder, and again, for a person as visual as I am, I think it is really cool to see what I can or cannot get or I have or have not done."*

Though the concept of RunDrawing was well received by the second participant, she expressed concerns. Since the concept was based on requiring the individual to carry mobile phone when he/she was physically active, she was concerned about how to utilize this concept for people like her not carrying their phones while doing excise:

*"When I am working out, I am actually tried not to carry my phone with me, just because I found it a little bit distraction. But if it could be transferred into something like a watch, that would be perfect."*

**Suggestions of Other Display Possibilities for RunDrawing**

As the previous chapter suggested, RunDrawing is intended to sustain an individual's interest and to cater to his/her personal style. RunDrawing offers different choices of themes to account for individual preferences and to prevent the initial enthusiasm about the visuals from wearing out.

Other display possibilities which were raised by the participants, were the suggestions that a famous painting could be used that progressively revealed as activity increases; a personal picture from their photo album being a mosaic with family faces that shows up at the end of the day; and having inspirational messages blooming on the screen:

- **A famous painting that progressively revealed**

  *So I would be more interested, if it is actually a painting more like involving a specific sample painting, an actual painting… and at the beginning of the day, I maybe just saw, an eyeball, then the end of the day it progressed into an picture. I may be interested to actually do more exercise because I am curious to know if I can guess the art work, involving on the screen. I probably would be thinking of that work if I can guess that shot or whatever it is. I will be able to get more hints when today goes by. That would be more interesting as it opposed to such an abstract concept.*

This design suggestion might be attractive to some people who have considerable knowledge and interest in Fine Arts; it is not anticipated to be applicable for a wider user group.

- **A personal picture from their photo album being a mosaic**

*"Maybe photo album will end up being a Mosaic at the end of the day of family faces or something, I might be interested keeping that because this app built me that picture for me."*

The general idea was appealing but the concern was that such a metaphor may not be appropriate for a lock screen background or a screen saver of people's personal phone because of the sensitive nature of them.

- **Blooming inspirational messages**

*"I am also a big fan of inspirational messages. If you have motivational positive messages that are creating a mosaic, maybe that starts to be appealing… all day long it is exercising and getting new positive messages blooming on the screen that would be pretty. That would be something that keeps me more focused."*

### *6.1.2 Focus Group Study*

The focus group study solicited feedback on perceived usability of the RunDrawing system and collecting design recommendations to improve the overall concept. All of which served to help evaluate whether the proposed design would work well if it could

be realized as a prototype system. The focus group study covered a range of open-ended questions about participants' opinions about using the RunDrawing system and the perceived usefulness of this concept in encouraging regular physical activity. In addition to examining the validity of the RunDrawing concept, questions that addressed how to further improve the design concept were also included in the focus group session.

The focus group study was conducted in-person, at a one-time event, in a meeting room at University of Alberta. Potential participants were identified by students who are currently enrolled in the art and design programs. Recruitment was done via email invitations sent out by administrative office in the Department of Art and Design. Eleven participants agreed to be part of the focus group study. Estimates from conducting the focus group session determined that it could be completed in 30-50 minutes, depending on responses provided to the open-ended questions. The entire focus group session was audio recorded under the permission of each participants at the beginning of the activity and was then transcribed. The proposed RunDrawing concept was represented using a slide show (PowerPoint) and explained in-person during the focus group session.

### Study Details and Study Participants (N=11)

The focus group session was conducted in May of 2015 with eleven participants, five men and six women, participating in the group. Participants ranged in age from 20-27 years old and all were currently enrolled in Art and Design courses, but were in different years of university—three first and second year undergraduate students, four third year undergraduate students, and one second year masters student. Among all the participants, four of them were studying Visual Communication and seven of them

were studying Industrial Design. All were regular smart phone users with eight of them had experiences of using fitness apps to increase physical activity and three of them had experiences of using commercial weight loss/control apps to maintain and lose weight. No one reported a case of significant weight loss using any weight loss/control app. According to Stages of Change Model (Prochaska, DiClemente, & Norcross, 1992), three participants out of eleven were defined as precontemplators because they have no intention to lose/control their weight; five participants were recognized as contemplators as they showed interest in incorporating regular physical activity to control and lose weight, but had not taken action yet; and the remaining three were identified as being in the preparation stage because all of them had tried to and were motivated to lose/control their weight, but have not managed to do so. The focus group session lasted 45 minutes in total and was audio recorded and transcribed.

The focus group discussion centered around nine open-ended questions. Most of which served to examine the perceived usability (ease of use) and the usefulness (value) of the RunDrawing concept. Others were used to solicit design recommendations to improve the overall concept. The open-ended questions were (partial of the question were as same as semi-structured interview):

- Would this design be able to make everyday workout less boring or more fun and enjoyable? How?
- How do you feel this design would provide you with a meaningful experience?
- Do you think the wall paper display would able to affect your physical activity awareness and behavior? How?

- How well does the dynamic abstract drawing provide an understandable representation of your goal attainment?
- Besides all themes mentioned in the presentation, are there any others that you think would interest you?
- What do you like about the idea?
- What do you dislike about the idea?
- Are you willing to share these kinds of non-literal activity drawings online with others? Why?
- Please include any feedback you have on how the design can be improved?

Due to the nature of the focus group session, it is reasonable that some participants expressed more about their personal opinions towards the design than did others. The majority of participants stayed active during the research activity. General results and reactions to the RunDrawing concepts are listed in the following.

### Overall Reactions to the RunDrawing Concept

The focus group session served to measure whether the proposed RunDraing concept would work reasonably well if it could become a commercial product, in addition to soliciting design recommendations to improve the overall concept. Participants were asked to speculate about their use of RunDrawing. Overall, responses and reactions from focus group session were overwhelmingly positive.

Regarding the open-ended questions asked about the overall RunDrawing's concept, most participants appreciated how the drawing display functioned, especially the "glanceable" (Matthews, Forlizzi & Rohrbach, 2006) nature of the data visualization:

*"I really enjoy your using the sort of visual language… it is not a statistic numbers but a general overview of how you are doing which is easier to deal with and comprehends them."*

*"I really like just having generalized and abstract ideas of what are you doing and how you doing…"*

*"It does so by not giving you the puking data but just gives you a very subtle indication of 'oh, this is where you at'…"*

Several participants commented specifically on the subtilty of the display and how would it fit into their everyday life:

*"You barely know it is there. That's what I like about this and I think anything that capitalizes on that subtlety of like… it's there, it's not screaming for your attention."*

One participant particularly critiqued today's technology that uses notifications to remind people about their commitment to being active. He pinpointed the importance for designers to consider design for subtilty, as today's technology is all about attention capturing:

*"A notification saying that 'you are not being fit', I would hate that… 'oh, thank you for letting me know that I am not being active…"*

*"We need more of design interventions that are designed to be subtle and invisible as opposed to the ones that are screaming for your attention…"*

Most participants expressed that they liked the drawing display in particular. Some participants mentioned the completed and matured drawings were very motivating as well as aesthetically pleasing. In their words:

*"It's 24th century art. It transforms art into this type of thing (using dynamic drawing to represent behavior information) that used to be a static thing that you would enjoy. You, as the person creating the activity, are part of the art progression as the arts can transform itself…"*

*"I love the creation part of this concept… I am creating something. I am progressing and creating…"*

*"Artistically speaking, it could be very interesting in the way that, you know, like, what the finished piece (looks like)… I think it is cool that way, from the arts point of view."*

*"It is a very satisfying experience because if you put something into action you will see the rewards as a result. It motivates you even more."*

Participants also appreciated how simple and understandable the drawing display was, in how it visualized behavioral feedback:

*"It basically just kind like gives you a good read of where you are throughout the day…"*

*"This (drawing display) is for that like just get an idea of, you know, "oh yeah, I have had a pretty active week," or "no I need to hustle a lot", I think that suits perfectly."*

*"People don't often take into like 'oh I burned two hundred and ten calories today' as easily as like 'oh it (the drawing created by the individual) is really gloom today' people's brain tends to prefer more generalized data."*

Aside from responses and feedback about the displaying component of RunDrawing, the concept of RunDrawing's other component—the interactive gallery—was also well received:

> *What I liked about this gallery is that it gives an association… a sort of a reminder of a time period. You know, if we have been following this image through the course of the week and then two months later, we are flipping through the gallery, we see that we may have a better association of what that week looked like rather than if we just had the raw data.*

**Suggestions for Improving the RunDrawing Concept and Recommendations of other Themes for the Background Display**

In order to consolidate the overall concept of RunDrawing, participants were asked to include any additional feedback on how the concept could be made more appropriate and appealing for them.

Overall, participants valued how the RunDrawing concept functioned. However in terms of future improvements, participants expressed their own ideas. One suggestion included having a range of customizable settings, for example, users would be able to pick colors or patterns that they like or at least be able to determine what the default color palettes would be to influence the drawings.

- **Having customizable settings (Comments in their own words) :**

*"It also would be nice if I can choose…like, colors… so if I start to working out, maybe I can choose colors or I can choose some patterns or different style of brushes or something like that… It is very nice feeling if you can personalize it."*

*"You can maybe have like (a set of) alternatives (of the color themes to choose from), I know a lot of girls are really into pastel kind of color…"*

*"Having an auto setting for progressing the painting and a customizable setting so that you can choose from."*

- **The correlation of "running drawings" with personal photos**

It is important to note that, one of the participants also commented there is a need to correlate the drawings with his personal photos so that the drawing could become more like his *"own creative work."* This suggestion had some similarities with the idea that "having a personal picture from their photo album being a mosaic" which proposed by the participant in the semi-structured interview. These findings suggest that there is a need to discover other possibilities which present behavior information in a way that personally meaningful to the user as individual. Comments from the participants who attempted to search for specialty in the sense of individuality:

> *I am curious to see how valuable it is to correlate the painting gallery with my photo gallery in giving me a better idea of what I did during the week. The gallery idea is interesting, but if it is not your own creative of work; it almost feels like, well, I am going to be looking at the same gallery as everybody just looking at.*

- **A drawing display that supports more detailed behavior information visualization**

Despite the fact that most participants found the drawing display simpler to engage with as it helped them reflect on their behavior more directly, one participant expressed concerns. She suggested that she would want the drawing display to tell "a little bit more" about users' behavioral information:

*"If it could be designed to let people to know a little bit more (about their behavior pattern in the day)… be like, different parts of the screen represents different times of the day."*

Though it is possible to realize this idea from a programming point of view, from a developer's point of view, this default setting and the way the algorithm works, could possibly result in similar-looking drawings separated by different users.

- **A musical theme**

A suggestion of a music-related theme was raised when asked for different themes other than what had been provided in the presentation:

*"Could have musical themes…Using music to create the complexity (of the drawing)…"*

The overall responses to the RunDrawing concept from the focus group session has been reviewed from three points of view: (1) how important participants thought the lock screen background display and the interactive gallery were as essential

components to RunDrawing; (2) How they liked the drawing display, particularly, its subtle and glanceable nature of data visualization; (3) and how they thought the drawing display supported a simple and understandable presentation of an individuals' physical activity behavior and goal attainment. A discussion of how participants thought the concept of RunDrawing could be improved was also provided.

Next, results from both the semi-structured interviews and the focus group study which relate to the design strategies and principles from Chapter 4 that informed and guided the design of RunDrawing, are explored.

## 6.2 Supports for Design Strategies and Principles

Three of four design principles that were proposed by Matthews, Forlizzi, and Rohrbach (2006) and five of the eight design strategies suggested by Consolvo (2008), are supported by results from this chapter. Findings indicate the design procedures and the design considerations that have been adapted for conceptualizing RunDrawing are valid. They have strong implications for informing the design of persuasive technologies for lifestyle behavior change.

### *6.2.1 Support for Glanceable Display Design Principles*

- **Support for the *Match user expectations* Design Principle**

Participants' comments about how well the RunDrawing's lock screen background display offered them an understandable representation of their goal attainment and behavior information supports the *Match user expectations* design principle.

Many participants explained how easily they found themselves engaging with the RunDrawing's display:

*"I thought it (RunDrawing's background screen display) is pretty straight forward. I saw how I got involve, and I thought you could probably get a good idea of what has been done".*

> *The only thing I can even think of that's close parallel, is like 'the day' seeing the sun that hang around ourselves so that we can kind of get a measure of the time…We just know roughly where we are (in the time of the day), and that's what the sun does and it does a really good job of giving us an internal clock without actually having look at the clock. And this (Rundrawing's display), in a very different way, achieves the same thing.*

- **Support for the *Use abstraction representations* Design Principle**

Participants' reactions to how they liked the data abstraction, as opposed to the use of explicit data to represent goal attainment and behavior information, supports the second point of Matthews, Forlizzi and Rohrbach's design principle: use abstraction representations.

Comments about the notion of using data abstraction rather than using explicit data were overwhelmingly positive:

*"It (abstract drawing display of RunDrawing) does so by not giving you the puking data but just gives you a very subtle indication of 'oh, this is where you at' and if you want to dig deeper you can dig deeper. I like that."*

*"I really enjoy your using the sort of visual language… it is not a statistic numbers but a general overview of how you are doing which is easier to deal with and comprehends them."*

*"People don't often take into like 'oh I burned two hundred and ten calories today' as easily as like 'oh it (the drawing created during activity) is really gloom today'. People's brain tends to prefer more generalized data."*

*"I really like just having generalized and abstract idea what are you doing and how you doing…"*

- **Support for the *Make visuals distinct* design principle**

Participants' thoughts about how clear and understandable the three changing stages of the abstract drawing were: vacant, solid and booming, as well as how well do these different visuals facilitate self-reflection, further supports the third point of Matthews, Forlizzi and Rohrbach's design principle: make visuals distinct.

Most participants commented about how well do the different stages of the drawing provide a "pretty straight forward" indication of their goal attainment:

*"It's basically just kind of giving you a very good read of where you are throughout the day."*

*"I thought it is pretty straight forward"; "It give you a great glimpse of where you at."*

### *6.2.2 Support for Design Strategies proposed by Consolvo (2008)*

- **Support for the *Abstract & Reflective* Design Strategy**

This design strategy is very similar to the second design principle of Matthews, Forlizzi, and Rohrbach's design principle and has been discussed in the above context.

- **Support for the *Unobtrusive and Public* Design Strategies**

Participants' reactions in terms of the subtle and inconspicuous nature of RunDrawing's display supports the second and third design strategies of Consolvo: unobtrusive and public.

Many participants were satisfied with RunDrawing's unique way of data visualization as it required a small amount of attention to be useful. It is less likely to draw the unwanted attention of others and largely supports opportunities to ignore the data:

*"You barely know it is there. That's what I like about this, and I think anything that capitalizes on that subtlety… it's there, it's not screaming for your attention."*

*"Those subtle interventions… I think that there is a huge amount of demand for them."*

- **Support for the *Aesthetic* and *Positive* Design Strategies**

Participants' thoughts on how they liked the visual metaphor of RunDrawing's display and how satisfying the drawings were in rewarding the impressive physical activity behavior support the fourth and fifth design strategies of Consolvo: aesthetic and positive.

Some participants commented about their perceived gratification when imagining themselves using RunDrawing and the potential of it to provide them with a meaningful experience through use:

*"Artistically speaking, it could be very interesting in the way that, you know, like, what the finished piece (looks like)… I think it is very cool that way, from the arts point of view…"*

*"I think it is a very nice (thing) to have… even if I did only fewer workouts, but I am still able to get something beautiful."*

*"It is a very satisfying experience because if you put something into action you will see the rewards as a result. It motivates you even more."*

*"I love the creation part of this concept… I am creating something. I am progressing and creating."*

### *6.2.3 Support for the newly proposed design strategy*

- **Support for *Variable Rewards* Design Strategies**

Participants expressed ideas on other possible stylized displays that they would like to see, and their desire of adding additional features which would allow users to pick colors and patterns they like support the newly proposed design strategy, variable rewards.

Comments and suggestions about other themes and features that are presented in this chapter not only address the individual's personal preferences, but also indicate that the element of mystery is an important component to RunDrawing. By offering new surprises and new experiences, it caters to the user's desire for novelty.

## 6.3 Chapter 6 Summary

In this chapter, findings from both the semi-structured interviews and the focus group session are described. The semi-structured interviews covered a range of closed-ended and open-ended questions about participant's attitudes and experiences with commercially available weight loss/control apps, their physical activity patterns, and their feedback in terms of improving the graphic design for the RunDrawing's display. The focus group study especially focused on soliciting feedback about the usability of the RunDrawing system and collecting design recommendations to further improve the design concept.

Overall, findings from both the semi-structured interviews and the focus group session strongly suggest that most participants found the drawing display very appealing when they were introduced to it. One participant out of 13 was not interested in the concept maybe because she was at the maintenance stage which makes her unsuitable for the target user group. This chapter provided evidence through the evaluation of participants' responses, which showed that most participants appreciated how RunDrawing functioned. They liked the subtle and "glanceable" nature of its data visualization; the abstract drawing display offers a simple and understandable representation of physical activity behavior and goal attainment; and the potential of RunDrawing providing gratification through use.

Participants' suggestions about how to improve the abstract drawing display included: having a range of customizable settings from which the user can pick colors and patterns; finding links between their personal photos and drawings in order to sustain a sense of individuality and be personally meaningful; and supporting for more detailed behavior information visualization. Participants' preferences for other display metaphors include a musical theme, a blooming inspirational messages theme, and a famous paintings puzzle theme.

# Chapter 7

# SUMMARY, LIMITATIONS, CONTRIBUTIONS, AND IMPLICATIONS FOR FUTURE WORK

This thesis project has uncovered some implications for future work in the field of Persuasive Technology, Ambient Display and Public Health. In Chapter 1 the promising opportunities for using persuasive technologies to promote healthy behavior change suggested that enhanced physical activity is one of most important lifestyle behaviors. It needs to be adopted given the rising sedentary behavior among children and adults, which is being blamed as one of the main contributors to the high rates of obesity.

In Chapter 2, overviews of three theories from behavioral psychology were provided. These theories help to address the often-ignored aspect of incorporating theory-based strategies into the design of technologies aimed at promoting behavior change.

In Chapter 3, research from empirical projects and studies that have developed persuasive technologies to encourage physical activity and other healthy behaviors were presented and discussed. All of the research investigated the use of stylized displays to facilitate self-reflection on individual's patterns of behavior as part of an effort to facilitate healthy behavior change.

Chapter 2 and 3 have suggested that designing persuasive technology to help individuals build healthy habits towards their desired lifestyle is complex. Chapter 4 introduced several research efforts that had developed frameworks and approaches to guide the design of persuasive technology which includes the following: Fogg's

'Eight-Step Design Process' (2009), Glanceable Display Design Principles (Matthews, Forlizzi, and Rohrbach, 2006), and a set of strategies established by Consolvo (2008). Fogg's 'Eight-Step Design Processes' is adopted to guide the early stage formation of RunDrawing. These design processes were then expanded by Matthews, Forlizzi, and Rohrbach's 'Glanceable Display Design Principles' (2006) along with a set of strategies established by Consolvo (2008). A new strategy was proposed to further develop Consolvo's strategies was also introduced based on theories and related successful behavior change projects described in Chapter 2 and 3.

In Chapter 5, RunDrawing, the system that was designed for this thesis project was presented. RunDrawing is a persuasive technology system that utilizes an ambient display to motivate individuals to incorporate regular physical activity into their everyday routine. The two main components of the RunDrawing concept are: (1) a lock screen background display, and (2) an interactive gallery. The *lock screen background display* incorporates calm technology which uses a stylized and aesthetically pleasing information visualization of behavior and goal attainment to promote healthy behavior. The interactive gallery collects drawings from individuals' physical activity and allows their autonomy to edit, delete, and share their "running drawings". Each of the two main components were presented, followed by a discussion of how design decision making was influenced by the Glanceable Display Design Principles, the most relevant strategies of Consolvo, and the newly proposed design strategies from Chapter 4.

The qualitative analysis that was used to assess RunDrawing, which included in-depth semi-structured interviews and focus group study, was described in Chapter 6. This qualitative evaluation focused on findings from both in-depth interviews and focus group study and included representative quotations to describe the perspectives of

individuals in their own words. Deeper discussions about the participants' reactions to the main components of the RunDrawing system were examined specifically to address the understanding of the participants' perceptions of the usability and usefulness of the two main components and how important they were to the RunDrawing system. This chapter also focused on participants' suggestions about how to improve RunDrawing concept and recommendations of other themes for the background display. It also discussed how participants' responses to RunDrawing, which related to and supported the design strategies and principles from Chapter 4, informed and guided the design process of the RunDrawing.

## 7.1 Study Limitations

In the evaluation of RunDrawing, qualitative evidence suggested that most participants found the drawing display to be very appealing when they were introduced to it. Research findings provided evidence that most of participants appreciated how RunDrawing functioned, especially the subtle and "glanceable" nature of its data visualization and presentation. The abstract drawing display offered a simple and understandable representation of physical activity behavior and goal attainment. The participants' appraisal of the experience using the aesthetically pleasing drawing display was that it was satisfying. However, all this positive qualitative evidence does not necessarily mean that RunDrawing will effectively increase individuals' awareness of their physical activity pattern and be able to help them incorporate regular physical activity into their daily lives. It only shows strong suggestions that RunDrawing has potential to do so. In order to validate the usability and usefulness of the proposed concept of RunDrawing, a working prototype is needed that can be implemented for an operating smart phone system, such as

Android or IOS. Due to time and funding constraints, a fully functional working prototype which runs on a smart phone for identifying flaws in design is beyond the scope of this thesis project. The next step in this research would involve undertaking a larger study over a longer term with a larger number of participants. The findings of this thesis research hopefully could be used as a reference for a designer or an app developer to realize the system in the future.

## 7.2 Contributions

Although, the RunDrawing concept is not the first project to use real-time activity inference, stylized data visualization, and ambient display of behavior and goal attainment, it still is useful for the field of Persuasive Technology, Ambient Display and Public Health.

- **The RunDrawing Concept**

A concept was developed that uses a non-literal format drawing as a metaphor rather than using explicit data or numerical representation which most commercially available apps are adopting, to represent key information about the individual's physical activity behavior and goal attainment. The drawing created by the individual works as a psychological boost—similar to therapy apps, which intended to help him/her sustain a positive mindset. The three main changing stages of the drawing—vacant, solid, and booming offer distinct and recognizable changes in visual effects on the display to represent progress of individual's weekly goal attainment. Every stage of change in drawing conveys a hierarchy of behavioral information that is critical, but understandable, for the individual. The changes are distinct and identifiable from each other which support a quick interpretation by only a glance. As

RunDrawing display is intended to be implemented as the lock screen background of a smartphone, individual should receive frequent yet subtle reminders of their commitment.

- **Applications of Design Strategies and Principles**

A set of design principles and strategies to help develop frameworks and approaches to guide the design persuasive technology were identified and discussed in this thesis research. These design principles and strategies include the following: Eight-Step Design Process (Fogg, 2009), Eight Design Strategies (Consolvo, 2008), Glanceable Display Design Principles (Matthews, Forlizzi, and Rohrbach, 2006), and a new design strategy—Variable Rewards—which is proposed to further develop Consolvo's strategies. All of which were validated through the design and evaluation of RunDrawing as described in Chapter 5 and Chapter 6.

- **Applications of three behavioral psychology theories to the design of persuasive technology for behavior change**

This thesis research showed how three behavioral theories—Social Cognitive Theory (Bandura, 1997), Theory of Reasoned Action and Theory of Planned Behavior (Ajzen & Fishbein, 1980; Ajzen, 1985), and Stage of Change Model (Prochaska, DiClemente, & Norcross, 1992) can help address the often-ignored aspect of incorporating theory-based strategies in the design of technologies to promote behavior change.

- **Barriers to self-monitoring**

Through background research, this thesis provided a description of the possible reasons why people stopped self-tracking and monitoring. Findings included that the use of raw data presentation could result in more damage than good, data collection and presentation should take place in a more private manner, and technology should

offer interventions that frequently reminds an individual of his/ her commitments. In particular, the first barrier was supported by one of the Glanceable Display Design Principles (Matthews, Forlizzi, and Rohrbach, 2006), and the Eight Design Strategies (Consolvo, 2008), that is, *Use abstraction representations* and *Abstract & Reflective,* respectively. Findings also suggested that there is a lack of considerations in the design and development of weight loss/control mobile apps to help patients in coping with negative emotions arising from their weight loss/control journey, and quite often, poor emotional coping may result in patients reverting back to poor health habits which can directly contribute to weight regain.

In addition to the contributions summarized above, several implications for future work have also been suggested by this thesis project.

## 7.3 Implications for Further Work

Due to time constraints, this thesis project leaves many opportunities for future work.

- **A working prototype of RunDrawing and a larger sample size of participants**

As described in 7.1 limitations, it is hard to draw the conclusion that RunDrawing will effectively increase individuals' awareness of their physical activity patterns and be able to support them in the long term. Future research needs to investigate the effectiveness of RunDrawing when implemented on an operating smartphone system so that the research could go beyond testing assumptions about the concept of RunDrawing, but delve deeper into how the system was experienced by target users.

- **Exploring the RunDrawing display in other technology channels**

This thesis project explored RunDrawing as implemented on the lock screen background of a smartphone. However, future research could explore the effectiveness of the RunDrawing system when implemented on other types of technology channels, such as wearable devices.

- **Exploring the applicability of the drawing display to other types of behavior change**

This thesis research has explored using drawing display to increase physical activity level and behavior awareness. In the future, research could investigate the applicability of the drawing display to other types of behavior change, such as diet and smoking cessation.

This thesis project addressed the topic of designing persuasive technology to encourage regular physical activity for weight loss/control purposes. It developed an ambient display of behavior and goal performance to facilitate self-monitoring and specifically studied on information presentation to increase awareness of daily physical activity and behavior. The motivation of this work is to build an environment in which individuals can be aware of their behavioral states whenever and wherever they want to without utilization of explicit and raw data presentation. The design of RunDrawing system was presented and evaluated qualitatively to determine if the concept is acceptable as well as to explore further requirements of the system. Additionally, some design issues and study limitations were presented, which could be addressed to improve on the design concept in the future.

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# Appendix A: Ethics Application

Date: Friday, September 25, 2015 12:24:25 PM

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## 1.1 Study Identification

*All questions marked by a red asterisk * are required fields. However, because the mandatory fields have been kept to a minimum, answering only the required fields may not be sufficient for the REB to review your application.*

*Please answer all relevant questions that will reasonably help to describe your study or proposed research.*

**1.0** * **Short Study Title** *(restricted to 250 characters)*:
Theory-Driven Design Criteria for the Design of Mobile Health Application that Support Long-Term Behavior Change

**2.0** * **Complete Study Title** *(can be exactly the same as short title)*:

Theory-Driven Design Criteria for the Design of Mobile Health Application that Support Long-Term Behavior Change

**3.0** * **Select the appropriate Research Ethics Board (***Detailed descriptions are available by clicking the HELP link in the upper right hand corner of your screen***):**
REB 1

**4.01** * **Is the proposed research:**
Unfunded

**5.0**

* **Name of Principal Investigator** *(at the University of Alberta, Covenant Health, or Alberta Health Services)*:
Jiao Wang

**6.0**

**Investigator's Supervisor** *(required for applications from undergraduate students, graduate students, post-doctoral fellows and medical residents to Boards 1, 2, 3. HREB does not accept applications from student PIs)*

Robert Lederer

**7.0** * **Type of research/study:**
Graduate Student - Thesis, Dissertation, Capping Project

**8.01** **Study Coordinators or Research Assistants:** People listed here can edit this application and will receive all HERO notifications for the study:

| Name | Employer |
|---|---|
| There are no items to display | |

**9.01** **Co-Investigators:** People listed here can edit this application but do not receive HERO notifications unless they are added to the study email list:

| Name | Employer | Employer.ID |
|---|---|---|
| Mary Forhan | RM Occupational Therapy | 3402001 |

**10.01** **Study Team** *(Co-investigators, supervising team, other study team*

*members):* People listed here cannot edit this application and do not receive HERO notifications:

| Last Name | First Name | Organization | Role/Area of Responsibility | Phone | Email |
|---|---|---|---|---|---|

There are no items to display

### *1.5 Conflict of Interest*

**1.0** * **Are any of the investigators or their immediate family receiving any personal remuneration (including investigator payments and recruitment incentives but excluding trainee remuneration or graduate student stipends) from the funding of this study that is not accounted for in the study budget?**

○ Yes ◉ **No**

**If YES, explain:**

**2.0** * **Do any of investigators or their immediate family have any proprietary interests in the product under study or the outcome of the research including patents, trademarks, copyrights, and licensing agreements?**

○ Yes ◉ **No**

**3.0** * **Is there any compensation for this study that is affected by the study outcome?**

○ Yes ◉ **No**

**4.0** * **Do any of the investigators or their immediate family have equity interest in the sponsoring company? (This does not include Mutual Funds)**

○ Yes ◉ **No**

**5.0** * **Do any of the investigators or their immediate family receive payments of other sorts, from this sponsor (i.e. grants, compensation in the form of equipment or supplies, retainers for ongoing consultation and honoraria)?**

○ Yes ◉ **No**

**6.0** * **Are any of the investigators or their immediate family, members of the sponsor's Board of Directors, Scientific Advisory Panel or comparable body?**

○ Yes ◉ **No**

**7.0** * **Do you have any other relationship, financial or non-financial, that, if not disclosed, could be construed as a conflict of interest?**

○ Yes ◉ **No**

**If YES, explain:**

***Important***

*If you answered YES to any of the questions above, you may be contacted by the REB for more information or asked to submit a Conflict of Interest Declaration.*

## *1.6 Research Locations and Other Approval*

**1.0** * **List the locations of the proposed research, including recruitment activities. Provide name of institution or organization, town, or province as applicable**

The proposed research (which includes a focus group session with patients will take place on the telephone or in person with patients. The focus group with patients will take place in Toronto, Ontario, scheduled as a pre-conference research session at the Canadian Obesity Summit, 2015. Mary Forhan, a focus group co-facilitator, will be in the same room as the patient participants and the principal investigator (PI) will be co-facilitating the focus group using video conferencing (Skype) from a private office on the campus of the University of Alberta, Edmonton AB.

Patients living with obesity who are attending a patient engagement conference in Toronto will be asked to participate in the focus group. The focus group will take place on April 27, 2015 at 3:00 pm EST in the same room as the patient engagement conference in Toronto. Invitations to participate in the focus group will be sent out as an email by the Tracy Campbell, administrative assistant, on behalf of the Canadian Obesity Network who has permission to contact conference participants to engage in research activities. Patients interested in participating in the focus group will be asked to contact Jiao Wang (The Principal Investigator) directly by email. Jiao Wang will provide patients with information about the location and time of the focus group to be held in Toronto.

**2.0** * **Indicate if the study will use or access facilities, programmes, resources, staff, students, specimens, patients or their records, at any of the sites affiliated with the following** *(select all that apply):*

Not applicable

**List all facilities or institutions as applicable:**

**3.0**

**Multi-Institution Review**

* **3.1 Has this study already received approval from another REB?**

○ **Yes** ◉ **No**

**4.0**

**Does this study involve pandemic or similar emergency health research?**

○ Yes ◉ **No**

**If YES, are you the lead investigator for this pandemic study?**

○ Yes ○ No

**5.0** **If this application is closely linked to research previously approved by one of the University of Alberta REBs or has already received ethics approval from an external ethics review board*(s)*, provide the HERO study number, REB name or other identifying information. Attach any external REB application and approval letter in Section 7.1.11 – Other Documents.**

## *2.1 Study Objectives and Design*

**1.0** **Date that you expect to start working with human participants:**
4/20/2015

**2.0** **Date that you expect to finish working with human participants, in other words, you will no longer be in contact with the research participants, including data verification and reporting back to the group or community:**
9/30/2015

**3.0** * **Provide a lay summary of your proposed research suitable for the general public** *(restricted to 300 words)***. If the PI is not affiliated with the University of Alberta, Alberta Health Services or Covenant Health, please include institutional affiliation.**

The proposed research aims to present theory-driven design criteria for designing and developing a better persuasive application system that might prevent patients with chronic diseases from the abandonment of the system. The commercially-available mobile health applications nowadays are suffering from high abandonment rate, low adherence, and the lack of incorporation of theory in promoting behaviour change, thus, hinders a great number of users from maximizing the benefits of digital health services and in-home treatment. A well designed and theory-grounded mobile health application which enhances patient involvement and self-management capacity is significantly needed. The proposed research hopefully can shed some lights to the above issues.

**4.0** * **Provide a description of your research proposal including study objectives, background, scope, methods, procedures, etc)** *(restricted to 1000 words)***. Footnotes and references are not required and best not included here. Research methods questions in Section 5 will prompt additional questions and information.**

Research Objective:

The objective of the proposed research is to present theory-driven design criteria for designing and developing a better persuasive application system that might prevent patients with chronic diseases from the abandonment of the system. The commercially-available mobile health applications nowadays are suffering from high abandonment rate, low adherence, and the lack of incorporation of theory in promoting behavior change, thus, hinders a great number of users from maximizing the benefits of digital health services and in-home treatment. A well designed and theory-grounded mobile health application which enhances patient involvement and self-management capacity is significantly needed.

In addition to bridging theory and practice, research findings that draw form literature reviews will be adapted to propose creative solutions to application design for patients who suffering from obesity. The research objective will then be explored through the evaluation of whether the proposed design potentially improves patients' adherence to e-treatment and offers long-term support.

Background:

The background of this research is rooted in the idea that healthcare applications are being adopted by patients as they help to improve the adherence and hence can affect the quality of life. They can provide an effective technological solution to reduce the burden of clinical visits and the resultant time and costs that are subsequently incurred. However, more than two thirds of persons who download applications had stopped using them within 6 months. In addressing low patients' adherence to treatment regimen, a well designed, theory-grounded application which enhances patient involvement, motivation, and self-management capacities is needed.

Within this context, research will explore what are the design criteria for designing and developing a better persuasive application system that might prevent patients with chronic diseases from the abandonment of the system.

Methods:

Focus group sessions will take place with persons living with obesity who have identified as interested in talking about obesity as noted by their voluntary participation in a patient engagement conference being held at the Canadian Obesity Summit in Toronto on April 27, 2015. Patients will be asked, as a group, to identify problems of the mobile application based on their own experiences using mobile application technology. Discussions will also revolve around their feedback and responses to the new application design proposed by the PI.

**5.0** **Describe procedures, treatment, or activities that are above or in addition to standard practices in this study area** *(eg. extra medical or health-related procedures, curriculum enhancements, extra follow-up, etc)*:

**6.0** **If the proposed research is above minimal risk and is not funded via a competitive peer review grant or industry-sponsored clinical trial, the REB will require evidence of scientific review. Provide information about the review process and its results if appropriate.**
Not applicable

**7.0** **For clinical research only, describe any sub-studies associated with this application.**

## *3.1 Risk Assessment*

**1.0** * **Provide your assessment of the risks that may be associated with this research:**
Minimal Risk - research in which the probability and magnitude of possible harms implied by participation is no greater than those encountered by participants in those aspects of their everyday life that relate to the research (TCPS2)

**2.0** * **Select all that might apply:**

**Description of Potential Physical Risks and Discomforts**

| | |
|---|---|
| No | Participants might feel physical fatigue, e.g. sleep deprivation |
| No | Participants might feel physical stress, e.g. cardiovascular stress tests |
| No | Participants might sustain injury, infection, and intervention side-effects or complications |
| No | The physical risks will be greater than those encountered by the participants in everyday life |

**Potential Psychological, Emotional, Social and Other Risks and Discomforts**

| | |
|---|---|
| Possibly | Participants might feel psychologically or emotionally stressed, demeaned, embarrassed, worried, anxious, scared or distressed, e.g. description of painful or traumatic events |
| Possibly | Participants might feel psychological or mental fatigue, e.g intense concentration required |
| No | Participants might experience cultural or social risk, e.g. loss of privacy or status or damage to reputation |
| No | Participants might be exposed to economic or legal risk, for instance non-anonymized workplace surveys |
| No | The risks will be greater than those encountered by the participants in everyday life |

**3.0** * **Provide details of the risks and discomforts associated with the**

**research, for instance, health cognitive or emotional factors, socio-economic status or physiological or health conditions:**
The risk to research participants is minimal and no greater than what may be expected during regular discussions around design ideas/concepts. While expressing design concepts, graphics or images or any other visual representations will be used for helping participants to understand, exchange ideas, and elicit responses. Participants are not exposed to any visual or textual information that they would not encounter in their every life.

**4.0** * **Describe how you will manage and minimize risks and discomforts, as well as mitigate harm:**
The PI will manage and minimize the risks and discomforts by:
- Being aware of the ethical considerations of working with human participants
- Conducting studies in an ethical way, considering the comfort level of the participants, where possible and preserving the anonymity of participants through proper data collection, storage and disposal.
- Respecting the dignity of all participants involved in this study.

Participants will be fully informed of the objective of the research, and will make sure participants are comfortable at all times.Consent forms will be completed prior to each research method. Participants will be told that their participation is voluntary and that they can withdraw from the research activity at any time without penalty.

In the unlikely event that any participant becomes distressed or uncomfortable during a study, the activity will be stopped immediately and the participant will be referred to the appropriate personnel or family/ friends will be contacted.

**5.0** * **If your study has the potential to identify individuals that are upset, distressed, or disturbed, or individuals warranting medical attention, describe the arrangements made to try to assist these individuals. Explain if no arrangements have been made:**
Although risk to participants is minimal, if any participant becomes distressed or uncomfortable during a study, the activity will be stopped immediately and the participant will be referred to the appropriate personnel or family/ friends will be contacted.

## *3.2 Benefits Analysis*

**1.0** * **Describe any potential benefits of the proposed research to the participants. If there are no benefits, state this explicitly:**
There are no known benefits to the participants.

**2.0** * **Describe the scientific and/or scholarly benefits of the proposed research:**
The scholarly benefit of the proposed research is presenting design recommendations and potential persuasive technologies for mobile health application design to support long term behavior change. The issue of non-adherence to e-medical regime will also be discussed. The research adds on the body of knowledge of the use of behavior theory in app design which is usually ignored and lacked in this field.

**3.0** **Benefits/Risks Analysis: Describe the relationship of benefits to risk of participation in the research:**
As outlined above, the benefits to the participants in this study will far outweigh the minor risks involved.

### *4.1 Participant Information*

**1.0** * **Who are you studying? Describe the population that will be included in this study.**
The participants for the proposed research includes:

Focus group participants will be adults living with obesity who are participating in a voluntary patient engagement conference as part of the Canadian Obesity Summit in Toronto Ontario.

**2.0** * **Describe the inclusion criteria for participants (e.g. age range, health status, gender, etc.). Justify the inclusion criteria (e.g. safety, uniformity, research methodology, statistical requirement, etc)**

Inclusion criteria for patient participants for the focus group sessions will be adults living with obesity who are participating in a voluntary patient engagement conference as part of the Canadian Obesity Summit in Toronto Ontario.

**3.0** **Describe and justify the exclusion criteria for participants:**

**4.0**

* **Will you be interacting with human subjects, will there be direct contact with human participants, for this study?**
(●) **Yes** ( ) No
*Note: No means no direct contact with participants, chart reviews, secondary data, interaction, etc.*

**If NO, is this project a chart review or is a chart review part of this research project?**
( ) Yes ( ) No

**5.0**

**Participants**

**How many participants do you hope to recruit** *(including controls, if applicable)*
10
**Of these how many are controls, if applicable** *(Possible answer: Half, Random, Unknown, or an estimate in numbers, etc).*

**If this is a multi-site study, for instance a clinical trial, how many participants** *(including controls, if applicable)* **are expected to be enrolled**

**by all investigators at all sites in the entire study?**

**6.0 Justification for sample size:**

The number of participants in the focus group session is up to 5. The number of participants depends on the number of patients who show interest. The sample size for focus group sessions are sufficient for data collection and at the same time reasonable with respect to the timeline and scope of the proposed research.

**7.0 Does the research specifically target aboriginal groups or communities?**

○ Yes ◉ **No**

### *4.3 Recruit Potential Participants*

**1.0**

**Recruitment**

* **1.1 Describe how you will identify potential participants (please be specific as to how you will find potentially eligible participants i.e. will you be screening AHS paper or electronic records, will you be looking at e-clinician, will you be asking staff from a particular area to let you know when a patient fits criteria, will you be sitting in the emergency department waiting room, etc.)**
Focus group session: Persons living with obesity who have agreed to participate in a patient engagement workshop (a pre-conference event being held on April 27 2015 at the Canadian Obesity Summit, hosted by the Canadian Obesity Network) will be invited to participate in the focus group. An invitation request to participate in this research project will be sent by email on behalf of the research team by Tracy Campbell, an assistant working for the Canadian Obesity Network. Ms. Campbell has the email addresses for patient engagement workshop participants and has permission to contact them directly. A copy of the email to be sent to participants in included with this application.

**1.2 Once you have identified a list of potentially eligible participants, indicate how the potential participants' names will be passed on to the researchers AND how will the potential participants be approached about the research.**
Anyone interested in participating in the study will be asked to contact the PI directly.

**1.3 How will people obtain details about the research in order to make a decision about participating? Select all that apply:**

Potential participants will contact researchers
Contact will be made through an third party or intermediary (including snowball sampling)

**1.4 If appropriate, provide the locations where recruitment will occur** *(e.g schools, shopping malls, clinics, etc.)*

Once contacted by the participant, the PI will send a detailed information sheet with details about the project to the participant by email. A copy of the consent form will also be sent. Mary Forhan, who will be a co-facilitator of the focus group and who will be on-site in Toronto will obtain consent from participants prior to the start of the support group (Consent will be obtained between 8am-9am on April 27th prior to the start of the patient engagement workshop . Participants who have provided signed consent will be asked to attend the focus group in a room in the same building as the patient engagement conference starting at 3pm EST on April 27th.

**2.0**

**Pre-Existing Relationships**

**2.1 Will potential participants be recruited through pre-existing relationships with researchers** *(e.g. Will an instructor recruit students from his classes, or a physician recruit patients from her practice? Other examples may be employees, acquaintances, own children or family members, etc)***?**

○ Yes ◉ **No**

**2.2 If YES, identify the relationship between the researchers and participants that could compromise the freedom to decline** *(e.g. professor-student)***. How will you ensure that there is no undue pressure on the potential participants to agree to the study?**

**3.0** **Outline any other means by which participants could be identified, should additional participants be needed** *(e.g. response to advertising such as flyers, posters, ads in newspapers, websites, email, listservs; pre-existing records or existing registries; physician or community organization referrals; longitudinal study, etc)*

**4.0** **Will your study involve any of the following** *(select all that apply)***?**

None of the above

### *4.4 Third Party or Intermediary Contact Methods*

**1.0** **If contact will be made through an intermediary** *(including snowball sampling)***, select one of the following:**

Intermediary provides information to potential participants who then contact the researchers

**2.0** **Explain why the intermediary is appropriate and describe what steps will be taken to ensure participation is voluntary:**

Tracy Campbell, an assistant working for the Canadian Obesity Network, will be asked to send an email invitation to the patients who have agreed to participate in a patient engagement workshop (a pre-conference event being held on April 27 2015 at the Canadian Obesity Summit) and ask if they are interested in the research.

The intermediary is appropriate to ensure that anonymity of participants. At the first stage of the recruitment, the PI and her supervisor will not know to whom the invitation letter was sent, and will not have direct contact with

potential participants as Tracy Campbell will send the email invitation.

After the invitation letter was sent, potential participants will be identified by patients who showed interest in focus group and will contact the PI directly for their willingness of participation in the focus group session.

### *4.5 Informed Consent Determination*

**1.0**

* **Describe who will provide informed consent for this study (select all that apply). Additional information on the informed consent process is available at: http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter3-chapitre3/#toc03-intro**

All participants have capacity to give free and informed consent

**Provide justification for requesting a Waiver of Consent (Minimal risk only, additional guidance available at: http://www.pre.ethics.gc.ca/eng/policy-politique/initiatives/tcps2-eptc2/chapter3-chapitre3/#toc03-1b**

**2.0**

**How is participant consent to be indicated and documented? Select all that apply:**

Signed consent form

**Except for "Signed consent form" use only, explain how the study information will be communicated and participant consent will be documented. Provide details for EACH of the option selected above:**
Every invitation letter sent out to recruit participants will have attached an information letter describing the research background, objectives and procedures. At the beginning of the focus group session, the PI will also introduce research related info and explain consent information orally.

**3.0**

**Authorized Representative, Third Party Consent, Assent**

**3.1 Explain why participants lack capacity to give informed consent** *(e.g. age, mental or physical condition, etc.).*

**3.2 Will participants who lack capacity to give full informed consent be asked to give assent?**

○ Yes ◉ **No**

**Provide details. IF applicable, attach a copy of assent form(s) in the Documentation section.**

**3.3 In cases where participants (re)gain capacity to give informed consent during the study, how will they be asked to provide consent on their own behalf?**

**4.0 What assistance will be provided to participants, or those consenting**

**on their behalf, who have special needs?** *(E.g. non-English speakers, visually impaired, etc)*:
In case of special needs, the PI will ensure that all the necessary assistance will be available.

**5.0** * **If at any time a participant wishes to withdraw, end, or modify their participation in the research or certain aspects of the research, describe how their participation would be ended or changed.**

For the focus group sessions with patients, it is not possible to withdraw individual contributions to the research because data collected in the form of visuals (audio/video) or comments in focus group session are created collaboratively and within a group activity or discussion.

**6.0**

**Describe the circumstances and limitations of data withdrawal from the study, including the last point at which it can be done:**
For the focus group sessions with patients, it is not possible to withdraw individual contributions to the research because data collected in the form of visuals (audio/video) or comments in focus group session are created collaboratively and within a group activity or discussion.

**7.0** **Will this study involve any group(s) where non-participants are present? For example, classroom research might involve groups which include participants and non-participants.**

○ Yes ◉ **No**

## *5.1 Research Methods and Procedures*

*Some research methods prompt specific ethic issues. The methods listed below have additional questions associated with them in this application. If your research does not involve any of the methods listed below, ensure that your proposed research is adequately described in Section 2.0: Study Objectives and Design or attach documents in Section 7.0 if necessary.*

**1.0** * **This study will involve the following** *(select all that apply)*
*The list only includes categories that trigger additional page(s) for an online application. For any other methods or procedures, please indicate and describe in your research proposal in the Study Summary, or provide in an attachment:*
Focus Groups

**2.0** * **Is this study a Clinical trial? (Any investigation involving participants that evaluates the effects of one or more health-related interventions on health outcomes?**

○ Yes ◉ **No**

**3.0** **If you are using any tests in this study diagnostically, indicate the member(s) of the study team who will administer the measures/instruments:**

| Test Name | Test Administrator | Organization | Administrator's Qualification |
|---|---|---|---|
| There are no items to display | | | |

**4.0** **If any test results could be interpreted diagnostically, how will these be reported back to the participants?**

## *5.7 Interviews, Focus Groups, Surveys and Questionnaires*

**1.0**

**Are any of the questions potentially of a sensitive nature?**

○ Yes ◉ **No**

**If YES, provide details:**

**2.0**

**If any data were released, could it reasonably place participants at risk of criminal or civil law suits?**

○ Yes ◉ **No**

**If YES, provide the justification for including such information in the study:**

**3.0**

**Will you be using audio/video recording equipment and/or other capture of sound or images for the study?**

◉ **Yes** ○ No

**If YES, provide details:**
Audio/ video will be recorded during the focus group session. The PI will not use any of the images and recordings without having permissions to do so.

audio/video recording will only used to collect, analyse data and transcription.

## *6.1 Data Collection*

**1.0** * **Will the researcher or study team be able to identify any of the participants at any stage of the study?**

◉ **Yes** ○ No

**2.0**

**Will participants be recruited or their data be collected from Alberta Health Services or Covenant Health or data custodian as defined in the Alberta Health Information Act?**

○ Yes ◉ **No**

**Important:** Research involving health information must be reviewed by the Health Research Ethics Board.

**3.0** **Primary/raw data collected will be** *(check all that apply)*:
**Indirectly identifying information** - the information can reasonably be expected to identify an individual through a combination of indirect identifers (eg date of birth, place of residence, photo or unique personal characteristics, etc)
**All personal identifying information removed (anonymized)**
**Made Public and cited** (including cases where participants have elected to be identified and/or allowed use of images, photos, etc.)

**4.0** **If this study involves secondary use of data, list all original sources:**

**5.0** **In research where total anonymity and confidentiality is sought but cannot be guaranteed** *(eg. where participants talk in a group)* **how will confidentiality be achieved?**
All participants will be asked to keep confidential comments, ideas and information.

## *6.2 Data Identifiers*

**1.0**

* **Personal Identifiers:** will you be collecting - at any time during the study, including recruitment - any of the following *(check all that apply)*:

Surname and First Name
Email Address
Year of Birth

**If OTHER, please describe:**

**2.0**

**Will you be collecting - at any time of the study, including recruitment of participants - any of the following** *(check all that apply)*:

There are no items to display

**If OTHER, please describe:**

**3.0** * **If you are collecting any of the above, provide a comprehensive rationale to explain why it is necessary to collect this information:**
In order for PI to send further information with patients who already showed interest in participation through email, the PI has to collect email addresses and names.

For the focus group sessions, the PI has to collect the participants' year of birth, since the proposed design wants to satisfy different age range.

**4.0** **If identifying information will be removed at some point, when and how will this be done?**
Identifying information will not be added to any materials unless specified by the participants.

**5.0** * **Specify what identifiable information will be RETAINED once data collection is complete, and explain why retention is necessary. Include the retention of master lists that link participant identifiers with de-identified data:**
All data collected will remain unidentified.

**6.0** **If applicable, describe your plans to link the data in this study with data associated with other studies (e.g within a data repository) or with data belongong to another organization:**

## *6.3 Data Confidentiality and Privacy*

**1.0** * **How will confidentiality of the data be maintained? Describe how the identity of participants will be protected both during and after research.**
The privacy of all individuals involved in this research will be respected at all times. Confidentiality will be discussed at the beginning of every research activity.

**2.0** **How will the principal investigator ensure that all study personnel are aware of their responsibilities concerning participants' privacy and the confidentiality of their information?**

**3.0**

**External Data Access**

* **3.1 Will identifiable data be transferred or made available to persons or agencies outside the research team?**
○ Yes ◉ **No**

**3.2 If YES, describe in detail what identifiable information will be released, to whom, why they need access, and under what conditions? What safeguards will be used to protect the identity of subjects and the privacy of their data.**

**3.3 Provide details if identifiable data will be leaving the institution, province, or country** *(eg. member of research team is located in another institution or country, etc.)*

## *6.4 Data Storage, Retention, and Disposal*

**1.0** * **Describe how research data will be stored, e.g. digital files, hard copies, audio recordings, other. Specify the physical location and how it will be secured to protect confidentiality and privacy.** *(For example, study documents must be kept in a locked filing cabinet and computer files are encrypted, etc. Write N/A if not applicable to your research)*
All types of data including visual, verbal, and written data will be collected, documented, and stored on an external hard-drive, with password

protected, and stored in a locked cabinet. The locked cabinet will remain in the PI's home.

**2.0** * **University policy requires that you keep your data for a minimum of 5 years following completion of the study but there is no limit on data retention. Specify any plans for future use of the data. If the data will become part of a data repository or if this study involves the creation of a research database or registry for future research use, please provide details.** *(Write N/A if not applicable to your research)*
Data will be used for the Masters of Industrial Design thesis dissertation and report.

Data will be destroyed after 5 years following completion of study and research.

**3.0**

**If you plan to destroy your data, describe when and how this will be done? Indicate your plans for the destruction of the identifiers at the earliest opportunity consistent with the conduct of the research and/or clinical needs:**
Data collected will be destroyed and digital files will be erased after 5 years following completion of study and research.

## *7.1 Documentation*

Add documents in this section according to the headers. Use Item 11.0 "Other Documents" for any material not specifically mentioned below.

Sample templates are available in the REMO Home Page in the **Forms and Templates**, or by clicking HERE.

**1.0** **Recruitment Materials:**

| Document Name | Version | Date | Description |
|---|---|---|---|
| REVISED EMAIL INVITATION PATIENTS.doc \| History | 0.04 | 4/15/2015 10:05 PM | |
| REVISED EMAIL INVITATION PATIENTS.doc \| History | 0.02 | 4/15/2015 10:05 PM | |
| Newest version of email invitation letter \| History | 0.01 | 4/21/2015 3:26 PM | |

**2.0** **Letter of Initial Contact:**

| Document Name | Version | Date | Description |
|---|---|---|---|
| There are no items to display | | | |

**3.0**

**Informed Consent / Information Document(s):**

**3.1 What is the reading level of the Informed Consent Form(s):**

**3.2 Informed Consent Form(s)/Information Document(s):**

| Document Name | Version | Date | Description |
|---|---|---|---|
| REVISED-CONSENT FORM FOCUS | 0.04 | 4/16/2015 | |

| | | |
|---|---|---|
| GROUP.doc \| History | | 9:18 AM |
| REVISED-INFORMATION LETTER - FOCUS GROUP \| History | 0.06 | 4/16/2015 11:19 AM |
| Newest CONSENT FORM FOCUS GROUP \| History | 0.01 | 4/21/2015 3:30 PM |
| Newest information letter -focus group \| History | 0.01 | 4/21/2015 3:32 PM |

**4.0 Assent Forms:**

| Document Name | Version | Date | Description |
|---|---|---|---|
| There are no items to display | | | |

**5.0 Questionnaires, Cover Letters, Surveys, Tests, Interview Scripts, etc.:**

| Document Name | Version | Date | Description |
|---|---|---|---|
| SCRIPT- FOCUS GROUP \| History | 0.03 | 4/16/2015 11:20 AM | |
| EMAIL SCRIPT \| History | 0.01 | 4/15/2015 10:02 PM | |
| Newest script-focus group session \| History | 0.01 | 4/21/2015 3:34 PM | |
| Newest EMAIL script \| History | 0.01 | 4/21/2015 3:36 PM | |

**6.0 Protocol:**

| Document Name | Version | Date | Description |
|---|---|---|---|
| There are no items to display | | | |

**7.0 Investigator Brochures/Product Monographs** *(Clinical Applications only)*:

| Document Name | Version | Date | Description |
|---|---|---|---|
| There are no items to display | | | |

**8.0 Health Canada No Objection Letter** *(NOL)*:

| Document Name | Version | Date | Description |
|---|---|---|---|
| There are no items to display | | | |

**9.0 Confidentiality Agreement:**

| Document Name | Version | Date | Description |
|---|---|---|---|
| There are no items to display | | | |

**10.0 Conflict of Interest:**

| Document Name | Version | Date | Description |
|---|---|---|---|
| There are no items to display | | | |

**11.0 Other Documents:**

*For example, Study Budget, Course Outline, or other documents not mentioned above*

| Document Name | Version | Date | Description |
|---|---|---|---|
| INFORMATION LETTER-focus group.doc \| History | 0.05 | 4/16/2015 2:48 PM | |

***Final Page***

You have completed your ethics application! Please select "Exit" to go to your study workspace.

**This action will NOT SUBMIT the application for review.**

**Only the Study Investigator** can submit an application to the REB by selecting the "SUBMIT STUDY" button in My Activities for this Study ID: Pro00056234 .

You may track the ongoing status of this application via the study workspace.

Please contact the REB Coordinator with any questions or concerns.

# Appendix B: Interview Scripts, Questionnaires, and Information Documents

# Questionnaire

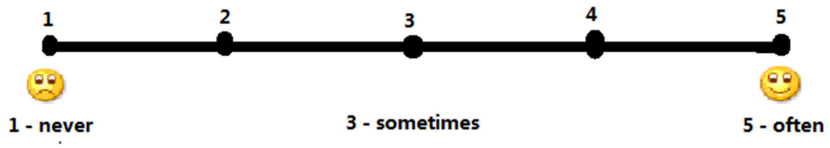
1. Please select your age from one of the ranges below:
   - 16-25
   - 26-35
   - 36-50
   - 51-70

2. Please select your gender:

   Male Female

3. How much experience do you have using mobile applications to control/lose weight?

   (The frequency scale is represented by the following diagram, please circle the corresponding number)




4. Please list some apps that you have used.

   ① _____
   ② _____
   ③ _____
   ④ _____
   ⑤ _____

5. Please rank the above apps from the best to the worst, using corresponding number it bears.

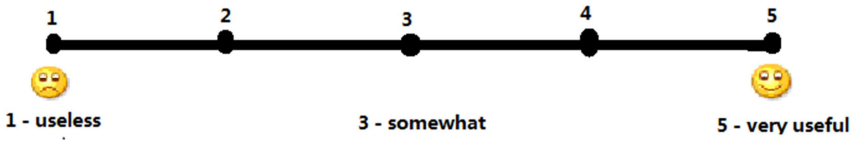
   _____

6. Please list your most favorite/useful one or ones (Leave it blank if there is no favorite ones and jump to question 8)

   ① _____
   ② _____

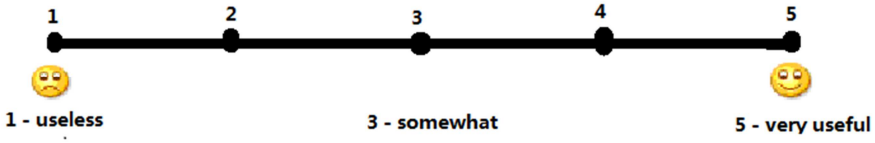
7. How useful are the most favorite apps you listed above, in your opinion?

(The usefulness scale is represented by the following diagram, please circle the appropriate number)




8. If there is no favorite app, how useful are the apps you listed in question 4 (apps you have used)?

(The usefulness scale is represented by the following diagram, please circle the appropriate number)




9. Please select the main sources where you learned about the apps you have used?

- Find by myself in Apps store/ Google play
- Recommended by clinicians
- Recommended by friends
- Online Advertisement
- Others _____

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**EMAIL INVITATION**

**Focus Group Session / Adults Living with Obesity**

**Study Title:** Colors That Prompts You: A Persuasive Ambient Activity Display—RunDrawing
**Principal Investigator:** Jiao Wang

Dear Participant of the Patient Engagement Workshop,

This message is being sent on behalf of a research team being led by Jiao Wang, a student in the School of Design, University of Alberta and her supervisor Prof. Robert Lederer. They are conducting a research study to design a mobile application to help individuals achieve the goals they set related to personal achievements including health behaviours. Participation in this study involves attending a one-hour meeting that will include up to 5 other persons living with obesity who have also participated in the Patient Engagement Workshop. The group meeting will take place immediately following the Patient Engagement Workshop in a meeting room at the Westin Harbour Castle Hotel on April 27, 2015. The group meeting will involve answering questions about your experience using mobile applications and your thoughts and opinions on the mobile application being proposed by the research team. Mary Forhan, a member of Jiao Wang's supervisory committee, will be present in the room to help co-facilitate the group discussion. Jiao Wang will be describing her proposed mobile application and asking questions using video conferencing (Skype) from a private office on campus at the University of Alberta, Edmonton Alberta.

If you are interested in participating in this study please send an email directly to Jiao Wang jiao4@ualberta.ca stating that you are interested in the study. Jiao Wang will contact you by email with more details about the study and confirm your participation.

If you are not interested in participating in this study, simply delete this message. We thank you for your time.

Thank you for your time and consideration.

Sincerely,
Jiao Wang

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## INFORMATION LETTER

**Focus Group Session**

| **Study Title:** Colors That Prompts You: A Persuasive Ambient Activity Display—RunDrawing | |
|---|---|
| **Research Investigator**<br>Jiao Wang<br>109 Industrial Design Studio (IND)<br>Edmonton, Alberta, T9G 2C9<br>jiao4@ualberta.ca<br>(780) 885 2198 | **Supervisor**<br>Robert Lederer<br>Industrial Design Studio (IND)<br>Edmonton, Alberta, T9G 2C9<br>rlederer@ualberta.ca |

Background

- You are being asked to participate in the research because your experiences and reflections will help me understand how to improve the design of a persuasive application system that might prevent patients with chronic diseases from the abandonment of the system.
- The results of this study will be used in support of my Master's thesis report, exhibition and presentation.

Purpose

- The objective of the proposed research is to present theory-driven design criteria for designing and developing a better persuasive application system that might prevent patients with a chronic disease from the abandonment of the app. Commercially-available mobile health apps nowadays suffer from a high abandonment rate and low adherence. The lack of incorporating theory-driven design in promoting behavioral change results in a majority of users from maximizing the benefits of digital health services. A well designed mobile health app. that enhances patient involvement and self-management is needed.
-

Study Procedures

- **You are being asked to participate in a focus group session around your experience and reflections with commercially-available mobile apps and your thoughts and opinions on the mobile application being proposed by me. The duration of the focus group session is around 1 hour and you are free to leave at any time during the discussion. For the focus group session, it is NOT possible to withdraw data since data is in the form of comments within a group discussion. Please note that audio/video recording in the focus group session will only be used to collect, analyze and transcript data, and that I will not use the recording in the Master's thesis exhibition.**

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Benefits

- The proposed research is presenting design recommendations and potential persuasive technologies for mobile health application design to support long term behavior change.
- The issue of non-adherence to e-medical regime will also be discussed.
- The research adds on the body of knowledge of the use of behavior theory in app design which is usually ignored and lacked in this field.

Risks

- The risk to participants is minimal. If I learn anything during the research that may affect your willingness to continue being in the study, I will tell you right away.

Voluntary Participation

- You are under no obligation to participate in this study.
- Participating in this research is completely voluntarily and has no penalty or gain attached to it.
- Even if you agree to be in the focus group session, you are NOT possible to withdraw data since data is in the form of comments within a group discussion. Personal contributions to group activity are very difficult to extract from the audio/video recording.

Confidentiality

- Collected data maybe shown in my Master's thesis exhibit and report and public presentations.
- You will not be identified by name in the exhibit and report, public presentation and in written dissertation.
- If it is necessary to quote you, a pseudonym will be used.
- Audio/ video recording will only be used to collect and analyze data. Audio/ video recording will not be used in the Master's thesis exhibition and/ or other presentations.
- Data will be kept in a secure place for 5 years following completion of research project, electronic data will be password- protected and devices will be encrypted. Data will be destroyed after 5 years.

**Further Information**

If you have any further questions regarding this study, please do not hesitate to contact me, Jiao Wang at jiao4@ualberta.ca or my graduate supervisor Robert Lederer at rlederer@ualberta.ca

The Research Ethics Board at the University of Alberta has reviewed the research plan, for its adherence to ethical guidelines. For questions regarding participants' rights and ethical conduct of research, contact the Research Ethics Office at (780) 492 2615. This office has no direct involvement with this project.

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# CONSENT FORM

**Focus Group Session**

**Study Title:** Colors That Prompts You: A Persuasive Ambient Activity Display—RunDrawing

**Principal Investigator:** Jiao Wang, University of Alberta, jiao4@ualberta.ca, (780)8852198

| | | |
|---|---|---|
| Do you understand that you have been asked to be in a research study? | YES | NO |
| Do you understand the benefits and risks involved in taking part in this research? | YES | NO |
| Have you had an opportunity to ask questions and discuss this research? | YES | NO |
| Do you understand that you are free to refuse to participate without consequence? | YES | NO |
| Do you understand that if you change your mind after you participate in focus group session, your comments may NOT be withdrawn due to the group nature of the activity? | YES | NO |
| Has the issue of confidentiality been explained to you? Do you understand who will have access to your information? | YES | NO |
| Do you understand that audio/video recording in the focus group session will only be used to collect and analyze data, and that I will not use the recording in the Master's thesis exhibition and/or other presentation? | YES | NO |

This study was explained to me by:_____

I have read and understood the attached information letter and agree to take part in this study:

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Signature of Research Participant _____ Date _____

Printed Name _____

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

Signature of Investigator _____ Date _____

A COPY OF THIS DOCUMENT SOULD BE GIVEN TO THE PARTICIPANT