

**Personality-Based Model-Driven Persuasive Application to Promote  
Mental Health and Well-Being**

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## **DEDICATION**

I dedicate this thesis to my husband

Turki Alqahtani

and

my parents

Hussein Alqahtani and Monerah Alqahtani

Both of you always supported me and motivated me to follow my passion.

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## ABSTRACT

Persuasive mental health applications (apps) are effective tools for promoting mental health and emotional well-being using various persuasive strategies. However, despite increasing interests, there is a lack of studies on how persuasive mental health and emotional well-being interventions can be tailored to individuals' personality traits.

To fill this gap, I developed a personality-based model-driven approach for tailoring persuasive mental and emotional well-being interventions to various personality traits. The personality-based model-driven approach was based on four major studies. In the first study, I conducted a comprehensive review of 69 technology-based mental health interventions from the literature to establish their effectiveness, and identify the persuasive strategies employed and their implementations. In the second study, I reviewed 103 mental health apps from app stores (App Store and Google Play Store) to identify various persuasive strategies/features employed in the design and their implementations. In the third study, I conducted six focus groups with 32 participants to uncover more insight regarding mental health app features. In the fourth study, I implemented 16 common strategies/features that emerged from studies 1, 2 and 3 in persuasive mental health app prototypes and conducted a large-scale study of 561 participants to evaluate their perceived effectiveness based on personality traits. The model revealed that some features/strategies were more effective for particular personality traits, thus, providing guidelines for tailoring persuasive mental health and emotional well-being interventions to various personality traits.

To show the feasibility of the personality-based model-driven approach, I applied the model from the fourth study to design and develop three versions of a persuasive mental health and emotional well-being app called "*Be Grateful*" targeting two distinct personality traits. To demonstrate the importance of tailoring persuasive mental health apps, show that it may be better to employ more than one appropriate strategy in mental health apps to increase their effectiveness, and that the negative effect of inappropriate strategies may cancel the effectiveness of appropriate ones when strategies are randomly selected, I conducted an evaluation (N = 240) of the three versions of the app over 5 weeks and interviewed 56 participants to gain more insight of their experiences with the app. The results show that although the tailored single-strategy version was ineffective compared to the contra-tailored single-strategy, combining multiple preferred strategies (two strategies) emerged to be more effective at promoting desired behaviour change and improving mental health than using a single preferred strategy in persuasive intervention design. However, combining appropriate strategies and inappropriate strategies in an intervention resulted in an ineffective app, showing the danger of a one-size-fits-all approach that is usually based on a random selection of strategies. Finally, the interview data provides detailed insight into why the app was effective.

## LIST OF ABBREVIATIONS USED

Apps	Applications
PT	Persuasive Technology
PSD	Persuasive Systems Design
BCT	Behaviour Change Techniques
TMHI	Technology-based mental health interventions
CBT	Cognitive Behavioral Therapy.
PPE	Positive Psychology Exercises
PED	Psychoeducation
MBSR	Mindfulness-based stress reduction
TM	Temporal model (focus on present)
ACT	Acceptance and commitment therapy
BA	behavioral activation (BA)
DBT:	Dialectical Behavior Therapy
MBCT	Mindfulness-Based Cognitive Therapy
SIT	Stress Inoculation Therapy
TMSC	transactional model of stress and coping
BD	Bipolar Disorder
TTSC	Transactional theory of stress and coping
BPD	Borderline personality disorder
PTSD	Post-traumatic stress disorder
RCT	Randomized Controlled Trial
WL	Wait-list

AMT	Amazon Mechanical Turk
PLS-SEM	Partial Least Squares (PLS) Structural Equation Modeling (SEM)
RM-ANOVA	Repeated-measure analysis of variance
KMO	Kaiser-Meyer-Olkin
CR	Composite reliability
AVE	Average variance extracted
HTMT	Heterotrait-Monotrait
FFM	The Big Five Factor Model
SUS	System Usability Scale
PSS	Perceived Stress Scale
WEMWBS	Warwick-Edinburgh Mental Well-Being Scale

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## CHAPTER 1: INTRODUCTION

Advances in technologies and the possibilities for using technology as a tool to assist and empower people to take care of their health and well-being have opened a new frontier in healthcare support. Consequently, research on how to use technology to motivate and assist users in living a healthy lifestyle has attracted the attention of both researchers and health practitioners. Research has shown the possibility of technology to encourage healthy behaviour in various domains, such as promoting healthy eating [177] and discouraging risky drinking behaviours [175], [169], manage diseases [128], and manage anxiety and achieve healthy living [114]. This type of technology is known as persuasive technology by Fogg [67]. .

Persuasive Technology (PT) is a term used to describe interactive applications (apps) designed to achieve a desirable change by influencing people to engage in certain behaviours without using deception or coercion. PT is widely used in the health and wellness domains to motivate and assist users in living a healthy lifestyle. In recent years, using PT in the area of mental health and emotional well-being has flourished. The design of such apps is an area of interest for mental health and emotional well-being researchers. Mental health issues have become a significant source of concern in our society due to the increases in their occurrence and the devastating effects it has on individuals, their loved ones and society as a whole. According to a survey by the World Health Organization World Mental Health, approximately 350 million individuals suffer from depression yearly [59]. Therefore, designing mental and emotional well-being interventions to assist individuals achieve better mental health is essential.,

Despite the increasing interest in this area, there is a need for research on how to design PT to promote mental health and emotional well-being to increase their effectiveness. This is the gap this dissertation aims to fill.



## 1.1 The Problem in Focus

The problem that this thesis address is that most existing technologies-based interventions for mental health take a one-size-fits-all design approach rather than tailoring their persuasive approaches to various users and user groups. Despite the growing interest in designing persuasive technology to promote mental health and emotional well-being, most existing technologies adopt a non-tailored approach in their design. However, research has shown that a PT that works for one person may not work for another because different types of individuals are motivated by distinct persuasive features. Hence, persuasive features that motivate one type of user may demotivate a different type of user [105], [166], [165]. Therefore, tailoring persuasive technology can improve its effectiveness in promoting the target behaviour compared to the generic persuasive technology [98]. However, research into various ways of tailoring persuasive and behaviour change technology to improve their effectiveness is still in its infancy, especially in the mental health domain. Moreover, most existing research in the mental health intervention has concentrated on tailoring the intervention's content [29], [33] rather than the persuasive strategies employed. Research also demonstrates that employing an ineffective strategy might be a significant obstacle to behaviour change. More importantly, none of the existing work has compared the effectiveness of employing single versus multiple persuasive strategies in the app and examined the effectiveness of including a combination of appropriate and inappropriate strategies in mental health interventions.

Thus, the following overarching question has guided my research work: *How can persuasive mental health and emotional well-being apps be tailored to various personality traits to increase their efficacy at motivating mental health behaviour change, and is there a value in tailoring persuasive apps for mental health and emotional well-being?*

## 1.2 Motivation Behind the Solution

Research has revealed that people differ in their motivation; hence, different types of individuals are motivated by distinct persuasive features, and what motivates one group of users may demotivate others. For example, Orji et al. [167] designed two versions of a

game tailored to two gamer type (Achievers and Conquerors) using a strategy that are appropriate for each gamer types. They found that players were persuaded more by the tailored version of the game than when playing the non-tailored versions. They stressed that designers should consider an individual's personality characteristics while selecting the most effective persuasion approach. Moreover, Kaptein et al. [105] conducted a study to compare the effect of tailored with contra-tailored strategies. They found that the contra-tailored strategies tended to increase the adoption of the unhealthy behaviour that the intervention had meant to decrease. Therefore, they concluded that the most important use of tailoring is to prevent the use of inappropriate persuasive strategies that can be counterproductive. Similarly, Segerstahl et al. [127] found that several persuasive strategies in use today evoke negative user experience (that discourages behaviour) because of a lack of tailoring of the persuasive strategies to the users. Therefore, they concluded that persuasive strategies should be tailored to achieve their intended goal of prompting behaviour change. Moreover, research suggested that applying many persuasive strategies in a persuasive intervention design may reduce the effect of the intervention [229] because one strategy may reduce the effectiveness of another, and multiple strategies may lead to an overly complex system that causes cognitive overload on the part of the users [109]. In contrast, research has shown that applying a single appropriate strategy in intervention design could be effective [167]. As a result, several studies of health technology have emphasized the need for more insight into various user characteristics that should be considered when tailoring persuasive interventions [169], [177],[175]. Finally, the lack of available guidelines for tailoring PT to various users and user groups leads to increasing adoption of the one-size-fits-all design approach. Designing tailored PTs would need rich knowledge of different user types and target behaviour. PT designers may not have the time, money, and knowledge required to gain insights and develop guidelines for tailoring PT before actual PT design.

### **1.3 The Solution**

To address this problem, this thesis introduces an approach for tailoring persuasive mental health interventions. In general, the personality-based model-driven approach for tailoring

persuasive mental health interventions comprises four major stages (see Figure 1.1): 1) Identifying persuasive strategies and their implementations stage, 2) Identifying features that users preferred in the mental health apps (focus-group study) stage, 3) Developing the personality-based model-driven approach stage, 4) Designing and evaluating the personality-based model-driven app stage.

### **1.3.1 Stage 1: Identifying Persuasive Strategies and their Implementations**

#### **Stage**

The first stage in developing the model-based approach for tailoring persuasive mental health and emotional well-being interventions is identifying the persuasive strategies and their implementations by reviewing existing research on technology-based mental health interventions (TMHIs) and reviewing mental health apps from app stores. This stage led to an empirical review of 18-years (from 2003 to 2020) of TMHIs studies and presented all the predominant persuasive strategies employed by studies to improve mental health and emotional well-being. This stage also led to the review and identification of various persuasive strategies employed in 103 mental health apps from the app stores (Apple's App Store and the Google Play Store). The details of these two studies are presented in Chapters 2 and 3.

### **1.3.2 Stage 2: Identifying Features that Users Preferred in the Mental Health Apps**

#### **(Focus-group study) Stage**

I conducted six focus group studies with 32 participants who have experienced mental health issues based on self-diagnosis. I aimed to explore the opinions, perceptions, preferences, and experiences to inform the design of a next-generation mental health app that would be engaging and effective at improving mental health and emotional well-being. The details of this study are presented in Chapter 4.

### **1.3.3 Stage 3: Developing the Personality-based Model-driven Stage**

The third stage, the modeling stage, uses the data from stages 1 and 2 to develop a personality-based model-driven approach showing the relationship between the persuasive

strategies and personality traits of users. I used the personality-based model-driven approach in tailoring persuasive mental health and emotional well-being apps. The details of the modeling process for personality traits are presented in Chapter 5.

### 1.3.4 Stage 4: Designing and Evaluating stage

The fourth and final stage involves applying the results from the models in designing and developing a mental health and emotional well-being app tailored to the user’s personality trait identified in stage 3. This stage basically involves three parts: (1) Selecting appropriate strategies for each user personality type from the models in stage 3 and determining the appropriate design implementation of the selected strategy from stage 1. (2) conducting usability testing of the app design and producing the final design of the app. (3) conducting a large-scale quantitative study to evaluate the three versions of app and interview study to gain more insight of their experiences with the app. The details of this stage are presented in Chapters 6,7 and 8.

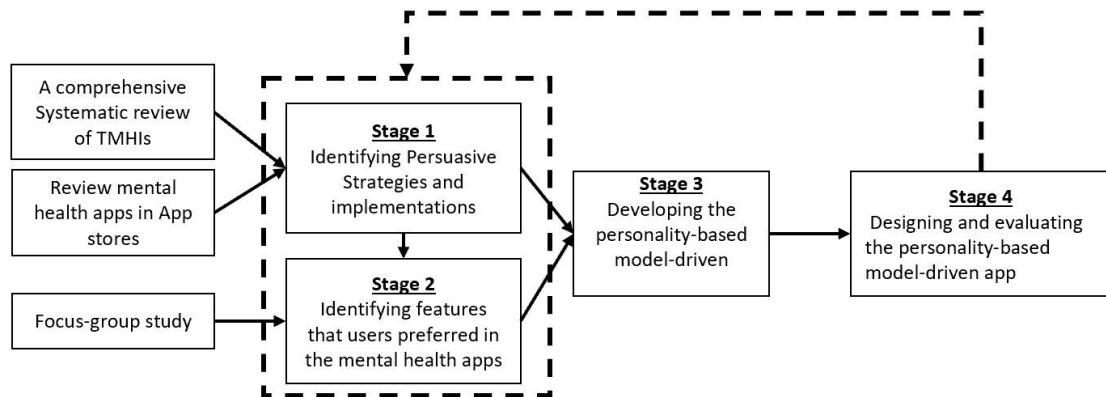


Figure 1.1 The four stages involved in the personality-based model-driven approach for tailoring persuasive mental health and emotional well-being intervention followed in this thesis

## 1.4 Contributions

This dissertation contributes to advancing the field of persuasive technology and the design of interactive applications for promoting positive mental health behaviour, mental well-being and reducing perceived stress by effectively answering essential questions:

*1) Is there any value in tailoring persuasive mental health apps using a single strategy?*

*2) Is there a need to employ multiple persuasive strategies to improve the effectiveness of the intervention?*

*3) Does employing inappropriate persuasive strategies cancel the effectiveness of the appropriate persuasive strategy when they are employed together in persuasive mental health apps?*

The dissertation effectively demonstrated that tailoring persuasive mental health apps using multiple strategies increases their effectiveness compared to using a single strategy. It also shows that using a combination of inappropriate and appropriate persuasive strategies reduces the effectiveness of interventions through implementation and large-scale field studies. The inappropriate strategy cancels the effectiveness of the appropriate strategies. Specifically, the dissertation made five main contributions to the field of persuasive technology and the design of interactive mental health apps for promoting mental health behaviour and improving mental well-being.

#### **1.4.1 Identified Persuasive Strategies and their Implementation**

I identified various persuasive strategies employed in the design of mental health apps and their implementations by conducting a comprehensive review of 69 technology-based mental health intervention studies and reviewing 103 mental health apps from the App Store and Google Play.

#### **1.4.2 Uncovered the Preferences, Needs, and Concerns of Mental Health App Users**

I conducted six focus groups with 32 participants to uncover more insight into mental health design. Focus group study contributes to advancing state-of-the-art mental health apps by exploring the preferences, needs, and concerns of mental health app users. It also sheds light on opportunities for future work in this area by offering recommendations for designing mental health apps that meet the unique needs of this population.

### **1.4.3 Developed Models for Tailoring Persuasive Strategies to Various Personality Traits**

I conducted cross-validation of the persuasiveness of 16 commonly employed PT strategies and developed models demonstrating the receptivity of the personality traits to the PT strategies based on a large-scale study of 561 participants. I proposed a personality-based model-driven for tailoring a persuasive mental health app. Based on the results from the models, I highlighted the most effective overall strategies that were perceived as positive by personality traits and the least effective strategies that were not perceived as persuasive by the personality traits.

Having persuasion profiles of different persuasive strategies that motivate various personality types provides a crucial methodological bridge between mental health app researchers and Persuasive Technology (PT) researchers and also between personalization researchers and PT researchers. The proposed personality-based model-driven approach for tailoring persuasive mental health apps benefits from the best practices of both app design and PT researchers.

### **1.4.4 Developed a Personality-based Model-driven Persuasive Mental Health App**

I designed three versions of a personality-based model persuasive mental health intervention (*Be Grateful app*) called tailored single-strategy version, tailored multi-strategy version and mixed-strategy version. *Be Grateful* was designed as a proof-of-concept persuasive mental health app to demonstrate the feasibility of the personality-based interventions that were informed by my model for tailoring persuasive mental health apps to personality types – Chapter 4. *Be Grateful app* was designed to motivate mental health behaviour (indicators: attitude, self-efficacy and intention), improve mental well-being and reduce perceived stress. The tailored single-strategy version was tailored to extraverted people using single strategy (this version is a contra-tailored for people who are open to new experience), and the tailored multi-strategy version was tailored to

extraverted people using two strategies while the mixed-strategy (two positive strategies and two negative strategies) was designed for openness people – Chapter 6.

I adapted only the persuasive strategies employed in the three versions of the gratitude interventions while keeping other design elements the same. Thus, the app's user experience is the same – only the persuasive strategies change. Through the design of *Be Grateful*, I show that persuasive mental health app designers do not have to design each app version from scratch to adapt it to the target audience. Tailoring can easily be achieved by incorporating appropriate PT strategies into an existing app.

### **1.4.5 Conducted a Large-scale Evaluation of the Personality-based Model**

#### **Mental health app**

I conducted a large-scale quantitative and interview study to gain deeper insights into the effectiveness of using the app by different personality types. The personality-based model-driven mental health app evaluation, which was intended to test the validity of my models for tailoring a persuasive mental health app to various personality types, shows that although the tailored single-strategy version was ineffective compared to the contra-tailored single-strategy, combining multiple preferred strategies (two strategies) emerged to be more effective at promoting desired behaviour change and improving mental health than using a single preferred strategy in persuasive intervention design. However, combining appropriate strategies and inappropriate strategies in an intervention resulted in an ineffective app, showing the danger of a one-size-fits-all approach that is usually based on a random selection of strategies. Finally, the interview data provides detailed insight into why the app was effective. The results from the evaluation answered the three main research questions of this dissertation.

### **1.5 Overview of Dissertation**

This dissertation has eleven chapters presenting the study details summarised in this introductory chapter.

*CHAPTER 1 INTRODUCTION:* This chapter gives an overview of the thesis, the problem statement, the solution approach for the problem and the contribution of each dissertation stage.

*CHAPTER 2 RESEARCH BACKGROUND AND RELATED WORK:* This chapter discusses the literature review related to this work and a comprehensive literature review of technology-based mental health interventions.

*CHAPTER 3 EVALUATING PERSUASIVE STRATEGIES IN MENTAL HEALTH APPLICATIONS:* This chapter discusses the persuasive strategies identified in mental health applications (apps) available in both stores (Google Play and App Store) and their implementation.

*CHAPTER 4 USER PERCEPTION OF MENTAL HEALTH APPLICATION:* This chapter discusses the details of the results of the focus-group study that was conducted to understand the opinions, perceptions, preferences, and experiences of people who have experienced some forms of mental health issues based on self-diagnosis to inform the design of a next-generation mental health app.

*CHAPTER 5 BUILDING THE PERSONALITY-BASED MODEL-DRIVEN APPROACH:* This chapter discusses the process of developing the model and shows the results of relationships between personality traits and features of a persuasive app for promoting mental and emotional well-being. Moreover, it presents the findings of possible domain-dependent variability in the relationship between personality and persuasive features across various domains.

*CHAPTER 6 DESIGN AND IMPLEMENTATION OF PERSONALITY-BASED MODEL-DRIVEN MENTAL HEALTH APP:* This chapter discusses the design and implementation of a personality-based model-driven persuasive mental health app (*Be Grateful app*) informed by design guidelines from the chapter 5.

*CHAPTER 7 USABILITY TESTING OF PERSONALITY-BASED MODEL-DRIVEN MENTAL HEALTH APP AND THE FINAL DESIGN:* This chapter discusses the usability testing of the designed app (*Be Grateful*) and provide the final design of the app.



*CHAPTER 8 PERSONLITY-BASED MODEL-DRIVEN MENTAL HEALTH APP EVALUATION:* This chapter contains the details of the evaluations of three version of the app.

*CHAPTER 9 RESULTS:* This chapter answers the three research questions of this dissertation with the results of the evaluations in a detailed manner.

*CHAPTER 10 DISCUSSION:* This chapter discusses the findings from this dissertation, and design recommendations.

*CHAPTER 11 CONCLUSION:* This chapter presents the contribution of this dissertation and outlines the future works.

## CHAPTER 2: BACKGROUND AND RELATED WORK

*Chapter overview:* In this chapter, I present an overview of persuasive technologies (PT) and their application in various domains, persuasive system design strategies and a comprehensive literature review of technology-based mental health interventions <sup>1</sup>.

### 2.1 Persuasive Technology and their Applications

Persuasive technology (PT) defined as an interactive system intended to motivate users to adopt healthy behaviours and ignore harmful ones. Using of PT to encourage desirable changes by shaping and reinforcing behaviours and/or attitudes has flourished in recent years. It has been argued that information and communication technology are never neutral, and they can influence people in one way or another [81]. However, PTs are intentionally designed to promote positive change that are beneficial to the user and/or their community.

Research has shown the possibility of persuasive technology in promoting users' behaviour in various domains. It has been extensively applied in the context of e-commerce for marketing [159], [157]. PTs are developed and used to motivate customers to adopt the systems and purchase products and services using various strategies. For example, Nkwo and Orji [170] conducted a study to identify persuasive technology strategies used in an African online marketplace called "Jumia" and determine users' awareness of the use of these strategies in Jumia. The results show that several persuasive technology strategies were employed on the Jumia e-commerce site, and users liked some of these strategies. For example, Jumia personalized and tailored content based on Users' purchase history, browsing history, and product information.

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<sup>1</sup> Submitted in Alqahtani, F., Orji, R., (under review). Why are Technology-based Interventions for Mental Health and Wellbeing Effective: State-of-the-Art and Emerging Trends. Behaviour & Information Technology.

Education is another significant domain of application of PT. In this domain, PTs were used to support students in achieving their goals. For instance, IJsselsteijn et al. [133] designed PT based on Gardner's theory that helps children students to develop a reading habit by encouraging them to improve their reading and writing skills. The results show the importance of employing similarity, tailoring, and credibility strategies, together with Gardner's theory, to motivate children to read and write.

Moreover, environmental sustainability is another significant field of using PT to motivate people to maintain the natural ecosystem. An example is "MatkaHupi" [101], a journey planning app that detects and tracks CO2 emissions of the trips and transport modes and uses this information to provide users with a set of actionable mobility challenges.

The health and wellness domain is considered a significant, important, and challenging domain that deserves special attention. Moreover, it has been stated that most of the health challenges people face today are due to their lifestyle and can be solved by motivating them to change their lifestyles [220]. Therefore, researchers believe that "designing persuasive systems that could resolve even some small parts of these problems and aid in true long-term sustainable change would be very valuable" [220]. In recent years, PTs have been employed in several health and wellness interventions to promote various health and wellness objectives, including promoting physical activities [9], encouraging healthy eating choices [176], reducing alcohol consumption [72], and improving mental health and emotional well-being [10].

The proliferation of mobile PT, such as smartphone apps, offers promising opportunities for deploying health behavioural change interventions that can reach a wider audience than face-to-face care. Mobile apps for health have clear advantages, particularly in mental and emotional well-being areas. First, the apps allow for monitoring of users' personal data related to their mental health issues, such as smartphone use frequency, frequency of calls and text messages, and other self-reporting behavioural data to prevent relapse [31], and the management of mental health issues [100]. Second, the apps allow user-tailored content delivery, such as providing users with timely strategies for coping with their mental health issues using their sensed information [18] and tailoring content based on user profiles.

## 2.2 Persuasive System Design Strategies

Persuasive systems are designed to encourage or influence people to engage in certain behaviours (e.g., engaging in physical activity, eating healthily, and stopping smoking) [67]. They are widely used in the health and wellness domains to motivate and assist users in living a healthy lifestyle. Over the years, frameworks and approaches have been developed to guide the design and evaluation of PT [67], [81], [150]. These frameworks highlight several persuasive strategies and behaviour change techniques in technology-based interventions to motivate the desired behaviours [166]. However, the Persuasive Systems Design (PSD) framework is one of the popular and widely adopted ones [81].

PSD framework developed 28 persuasive strategies and classifies them into four categories: Primary Task Support, Dialogue Support, System Credibility Support and Social Support. Each category consists of 7 persuasion strategies that are proposed to improve the system's persuasiveness and thereby the effectiveness at achieving their intended behaviour change objectives [81]: Primary Task Support design strategies support users in carrying out the intended behaviour and make it easy. The strategies in this category include reduction, tunnelling, tailoring, personalization, self-monitoring, simulation, and rehearsal. The Dialogue Support design strategies aim to keep the user active by making the system interactive and providing feedback, hence motivating them to use the system to achieve the intended behaviour. The strategies in the Dialogue Support are praise, rewards, reminders, suggestion, similarity, liking, and social role. The Credibility Support category describes how to design the system to be credible and trustworthy and promote intended behaviour. The persuasive strategies in the System Credibility Support category are trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. By employing these strategies, interventions can be perceived as more credible and therefore become more persuasive. The Social Support strategies leverage the power of social influence to motivate the users. The Social Support category consists of social learning, social comparison, normative influence, social facilitation, cooperation, competition, and recognition strategies. The definition of these strategies presents in Table 2.1.

Table 2.1 Definition of persuasive strategies in PSD framework

Primary Task Support	
Reduction	The system should reduce complex behavior into simple and easy tasks for the users to do the target behavior
Tunneling,	The system should guide the users in change process to bring them nearer to the target behavior
Tailoring	The system should offer tailored information for a user group based on their needs, personality or other factors related to the user group
Personalization	The system should provide personalized content and services for users
Self-monitoring	The system should track personal data and present a visualization of the collected user data
Simulation	The system should provide means for observing the connection between cause and effect of users' behaviour
Rehearsal	The system should deliver means for rehearsing the target behavior
Dialogue Support	
Praise	The system should provide praise for successfully completing a behaviour-related task via words, images, or sounds
Rewards	The system should offer virtual rewards after any accomplishment
Reminders	The system should remind users of their target behavior during using the system
Suggestion	The system should suggest a way to perform the target behaviours during using the system
Similarity	The system should remind users of themselves in meaningful way

Liking	The system should be visually attractive and contain look and feel that appeal the users
Social role	The system should adopt a social role that support the communication between users and specialist
Credibility Support	
Trustworthiness	The system should provide truthful, reasonable and unbiased information
Expertise	The system should offer information that shows experience and knowledge
Surface credibility	The system should have competent look and feel that portrays system credibility based on initial assessment
Real-world feel	The system should provide information of the organization or individuals behind its content or service
Authority,	The system should refer to the individual in role of authority
Third-party endorsements	The system should give endorsements from well-known and respected sources.
Verifiability	The system should provide outside sources to verify the accuracy of its content.
Social Support	
Social learning,	The system should allow users to observe other users' performance while they are doing target behaviour
Social comparison	The system should enable users to compare their performance with other users' performance
Normative influence	The system should gather people who have the same object together and make them feel norm

Social facilitation	The system should allow users to discern other users who are doing the same behaviour with them
Cooperation	The system should provide the opportunity for users to cooperate together to achieve their target goal.
Competition,	The system should allow user to compete with other users.
Recognition	The system should offer public recognition for user who are perform their target goal.

### 2.3 Mental Health and Emotional Well-being

Previously, the mental health care system has concentrated primarily on treating mental health disorders; nevertheless, it is recognized that this treatment-oriented method cannot sufficiently address the rising societal and economic costs of mental disorders [19]. Contrary to popular opinion, a rising body of empirical evidence suggests that mental well-being and mental illness are independent, albeit modestly associated, phenomena. To obtain a comprehensive understanding of mental health, it is necessary to understand the differences between mental illness and mental health. According to the World Health Organization (WHO) [232] mental health is defined as "a state of mental well-being that enables people to cope with the stresses of life, realize their abilities, learn well and work well, and contribute to their community." This definition shows that mental health is more than the absence of mental illness. Furthermore, mental illness is a disturbance in cognition, emotional regulation, or behavior that is clinically severe. Typically, it is accompanied with distress or impairment in vital areas of functioning [227].

Thus, prevention and promotion of mental health have received more attention in recent years. As result, the focus of my thesis is on improving mental health among the general population by promoting positive mental health in people and societies. This approach not only helps in reducing the incidence of mental illness but also increases the presence of positive mental health in people and societies [232].

## 2.4 Personality Theory and HCI

There are various ways for tailoring persuasive strategies in health interventions to increase their effectiveness. Player type models are one of the methods that can be used for tailoring persuasive interventions. For example, Bartle [28] classified players into four types: (1) killers, (2) achievers, (3) socializers, and (4) explorers. BrainHex model [154] also classified players into seven dimensions that can be grouped into three categories: (1) skill-oriented consists of Conqueror, Daredevil, and Mastermind. (2) aesthetic-oriented consists of Survivor, Socializer, and Seeker, and (3) goal-oriented consists of Achiever. Moreover, the Hexad model [142] classifies players into seven types: (1) Seeker, (2) Survivor (3) Daredevil, (4) Mastermind, (5) Conqueror, (6) Socializer, and (7) Achiever. The models mentioned above are player type models proposed to customize game and gamified experiences. However, some people do not play games, hence, the app design in this thesis is not a game-based application.

Models such as personality traits generalize to both gamers and non-gamers hence is ideal for tailoring an app to both gamers and non-gamers. Personality is a complex and multidimensional concept. It is the foundation of human behaviour, and there have been numerous models proposed to characterize and understand different personality types. As a result, we selected the Five-Factor Model (FFM) model [186] as the most widely used model of personality. It categorizes individuals based on five different personality dimensions. The FFM has shown to be effective for understanding personality types [147] and shows promise in predicting health-related behaviors [187]. It establishes a common taxonomy that is able to predict the differences in individuals' thoughts, feelings, behaviors, and actions [139]. The FFM consist of five personality traits:

- Extraversion refers to people who are outgoing, expressiveness, seek out new opportunities, and ambitious [186].
- Openness refers to people who are curious, imaginative, hold unconventional values, and creative [186].
- Neuroticism refers to people who are nervous, fearful, sensitive, distrustful, and emotionally unstable [186].



- Conscientiousness refers to people who are self-discipline, actively plan, goal-oriented, dependable, and organized [186].
- Agreeableness refers to people who are considerate, cooperative, tolerant, friendly, caring, and helpful [186].

Several HCI researchers have used the FFM to understand a user's motivation [99], and preference [183]. Some researchers have also investigated how persuasive apps may be personalized with respect to individual personality types. For example, Hirsh et al. [26] investigated the feasibility of tailoring persuasive messages for promoting physical activity to various personality types. Similarly, Arteaga et al. [22] studied the effectiveness of persuasive games for promoting physical activity tailored to various personalities. Orji et al. [169] investigated the variability in the effectiveness of 10 persuasive strategies for promoting health and wellness across various user's personality types. They focused more on apps for promoting healthy eating [177] and apps for discouraging risky drinking behaviours [169],[175]. Collectively, the findings from all these studies show the importance of tailoring the design of apps based on personality to increase their effectiveness. However, it has also been suggested that the effectiveness and persuasiveness of these strategies could be domain-dependent [167], [105]. A persuasive strategy that works for promoting behavior in the area of healthy eating may not work for physical activity for the same person. This study established this by showing that the relationship between personality and persuasive features vary across various domains, see Tables 5.2 and 5.7. To date, no existing work has investigated how persuasive apps for promoting mental health can be tailored to various personality traits. There is a need for research focusing specifically on mental health with the aim of investigating the persuasiveness of various app features and developing models for tailoring mental health apps to various users depending on their personality types. Employing persuasive features without taking into account users' characteristics could lead to negative consequences. For example, in a recent study active self-monitoring via an app was found to increase the likelihood of depressive episodes in patients with mental disorders [65]. Similarly, another study found that self-tracking of the users' worries triggered negative feelings such as depression, sadness, nervousness, anxiety [46].

Hence, there is a need for an exploratory study into the relationships between features employed in persuasive mental health apps and end-user's personality.

## **2.5 Comprehensive Systematic Review**

Advances in technologies and the possibilities of using them as tools to help and empower people to take care of their mental health and well-being have opened a new frontier in mental health care support. Using technologies as a delivery platform for mental health interventions offers the potential to reach large populations and overcome many barriers associated with face-to-face care.

Technology-based mental health interventions (TMHIs) have often employed evidence-based psychological therapy as theoretical frameworks programmed for websites, mobile applications (apps) or mobile games. These interventions are structured similar to face-to-face treatment, where contents and skills are taught with the anticipation that users will use them to improve their lives. However, the majority of people cannot use the intervention's content and skills because they must first know what to apply it to or which content/skills to be taught. In THMIs, information and communication technology are used to support and improve mental health and well-being. Several studies have developed and examined the effectiveness of their TMHIs that targeted various mental health issues, including general mental health [96], [32] stress [42], [34], depression [37], [209], and anxiety [200]. However, not all these studies reported successful outcomes with respect to achieving their design objectives. Thus, the reasons why some TMHI studies are effective while others are not unclear. This is because most TMHIs studies focus on the final outcomes, paying little or no attention to the technology design features and functionalities that may contribute to the effectiveness of TMHIs.

Thus, in this section, I fill this gap by presenting an empirical review of 18-years (from 2003 to 2020) of technology-based mental health interventions studies with the aim of 1.) answering important questions regarding whether there is a relationship between TMHIs design features/strategies and their effectiveness; 2.) highlighting and summarizing emerging trends in the technological intervention design, research method, target mental health issues, persuasive strategies employed in TMHIs and dropout rate of participants;

(3.) uncovering pitfalls of existing THMIs; and finally, (4.) suggesting directions for future research.

## **2.5.1 Materials and Methods**

I conducted systematic analysis and used the quantitative content analysis method which allows for classifying and categorizing the data based on various themes and principles [189].

### **2.5.1.1 Search Strategy**

For this systematic review, I searched various databases (e.g., Elsevier Scopus, APA Psycinfo, PubMed, IEEE, Springer, the ACM Digital Library, and Google Scholar) to ensure sufficient coverage of TMHIs across various disciplines such as behavioral science and mental health, medical and health informatics, health information systems, human-computer interaction (HCI). In addition, I reviewed the reference list of the selected publications to retrieve additional relevant publications. The search string used include ( Mental health OR Positive psychology OR Emotional well-being OR Mindfulness OR Meditation OR Emotion OR Low mood OR Mood OR Gratitude OR Grateful OR Relaxation OR Stress OR Depression OR Anxiety) And ( Persuasive Technology OR Behaviour Change Technology OR Technology OR Digital OR Internet OR Web OR Application OR Smartphone OR Mobile OR Computer). The search was limited to all papers published in English from 2003 to 2020 because Fogg [66] introduced the first paper in the field of persuasive technology as a seminar paper in 2002. Accordingly, most papers that designed persuasive technological interventions were published from 2003. The search resulted in 2236 unique titles, of which 543 articles were considered relevant following a title examination. After reviewing the abstracts of each article, a total of 69 articles are included in this analysis.

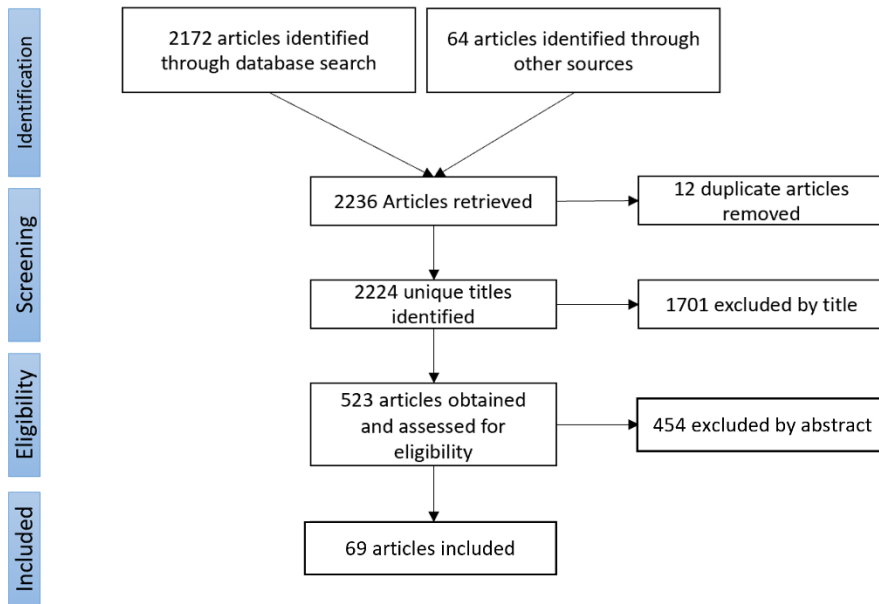


Figure 2.1 PRISMA flow diagram for the study selection workflow

### 2.5.1.2 Eligibility Criteria

I included studies that met the following inclusion criteria: 1) discussed the design and evaluation of TMHIs or an evaluation of existing TMHIs, 2) published in English between 2003 and 2020. The study identification process is summarized in Figure 2.1 [a PRISMA flow diagram [126]]. .

### 2.5.1.3 Data Extraction and Synthesis

I extracted the data from the included studies, verified it, and tabulated it for review using a coding scheme that was created and evaluated by Orji and Moffatt [168] with some additional data such as the dropout rate. Moreover, I used the PSD model to identify distinct persuasive strategies incorporated in TMHI. From the selected studies, I obtained the data shown in Table 2.2.

Table 2.2 Coding Scheme

<b>Identification</b>	<b>Meaning</b>
Study authors	The name of author(s) name who wrote the paper and conducted a study
Study title	The title of the article
Year of publication	When the paper was published
Country	Where the study was conducted
The delivery mode	The way intervention are delivered to users (web-based, mobile app, or mobile games)
The target issues of TMHIs	e.g., hours, days, weeks, months, and years
Evidence-based therapy	The evidence-based practice employed in the intervention
Behaviour theory	Theory used to inform what type of persuasive strategy employed in the intervention
Persuasive Strategy	Persuasive strategy employed in TMHIs
Evaluation methods	quantitative, qualitative, or both, including a control group, using RCT
Duration of evaluation	e.g., hours, days, weeks, months, and years
Target audience	Age range of participants (Children, Adolescent, young adult, adult, elderly)
Number of participants	Participants who participated in the study
Effectiveness of the study	Whether the intervention was able to achieve the design goal (fully successful, partially successful, or unsuccessful)

<b>Identification</b>	<b>Meaning</b>
Dropout-rate	The percent of participants who dropout of the study
Venue	Where the study was published

## 2.5.2 Results

The analysis of existing TMHIs revealed some interesting insights and trends. Below I present my findings under various categories.

### 2.5.2.1 Technology-based Mental Health Intervention by Year and Country

Table 2.3 and Figure 2.2 show that a relatively large proportion of empirical studies of TMHIs were published after 2010 compared to before 2010. There has been a sharp increase in the number of studies published from 2010 to 2016. The number of studies published reached the peak in 2016 and dropped in 2017 before rising again in 2018. It is necessary to mention that although the year 2020 seems to have the fewest number of studies since 2011, this is probably because most studies for 2020 are yet to be published at the time of this study, the third quarter of 2020.

Table 2.3 Technology-based mental health interventions trends by year

<b>Year</b>	<b>Studies</b>	<b>Total</b>
2003	[233]	1
2004-2007	non	0
2008	[34]	1
2009	non	0
2010	[228], [113], [152]	3
2011	[192], [144], [77], [37], [82]	5
2012	[62], [118], [226], [135]	4

Year	Studies	Total
2013	[223], [42], [64], [151], [197], [4]	6
2014	[138], [198], [5], [134], [107], [129]	6
2015	[32], [79], [137], [68], [87], [156], [116], [195]	8
2016	[193], [1], [46], [96], [83], [89], [70], [111], [149], [76], [63]	11
2017	[119], [31], [136], [188]	4
2018	[210], [30], [200], [124], [29], [25], [57], [48], [94]	9
2019	[100], [209], [219], [196], [20], [125], [51], [26], [84], [234],	10
2020	[130], [131]	2

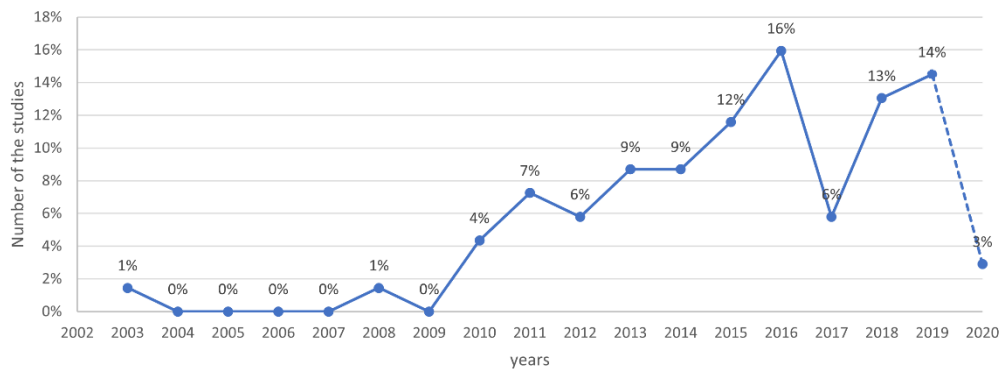


Figure 2.2 Technology-based mental health interventions trends by year

Moreover, Table 2.4 and Figure 2.3 show that the studies were conducted in 22 different countries, with most of the studies happening in the USA, 50%. This is followed by the Sweden and UK with 9%. Australia is in third place, with 8% whereas Germany and Canada are in fourth place with 4%. It is important to highlight that most of the studies happened in developed nations.

Table 2.4 Technology-based mental health interventions trends by country

<b>Country</b>	<b>Studies</b>	<b>Total</b>
USA	[119], [100], [31], [32], [209], [30], [193], [219], [1], [62], [192], [200], [96], [198], [5], [34], [68], [87], [151], [156], [197], [228], [37], [125], [152], [89], [70], [195], [76], [63], [57], [188], [234].	33
Sweden	[137], [138], [134], [233], [89], [135], [136]	7
UK	[42], [118], [70], [111], [48], [94]	6
Australia	[29], [89], [82], [26], [130], [25]	6
Germany	[83], [113], [84]	3
Canada	[20], [124], [116]	3
Italy	[223], [46]	2
Norway	[64], [129]	2
Swiss	[210]	1
France	[79]	1
Denmark	[196]	1
Ireland	[144]	1
Austria	[77]	1
Netherlands	[107]	1
Finland	[4]	1
Brazil	[51]	1
Korea	[149]	1
Poland	[89]	1
Switzerland	[89]	1
Malta	[89]	1



Country	Studies	Total
Singapore	[89]	1
New Zealand	[226]	1

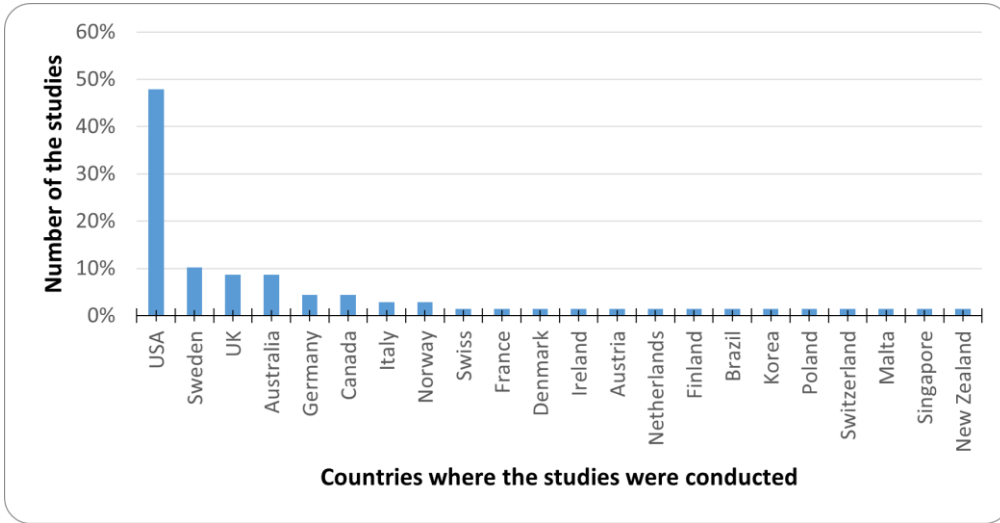


Figure 2.3 Technology-based intervention for mental health trends by country

### 2.5.2.2 Effectiveness of Technology-based Mental health Intervention Overall

I examined the effectiveness of the TMHIs based on whether the intervention was able to achieve the design outcomes as reported in the papers. I classified the effectiveness into four types: 1) fully successful (all design's goals achieved), 2) partially successful (some of the design's goals achieved) and 3) unsuccessful (failed to achieve the design's goals), 4) not specified (not specifying the outcomes of TMHIs).

Figure 2.4 summarizes the results of the effectiveness of TMHIs reviewed in this study overall. I found that of the 69 reviewed studies, 28% studies reported fully successful outcomes from using the TMHIs. Fifty-one percent (51%) of studies reported partially successful outcomes. Only 9% of all the studies were unsuccessful at achieving their

intended objective and 13% of the studies did not specify whether the intervention was effective or not. The results of the effectiveness of TMHIs are detailed in Table 2.5.

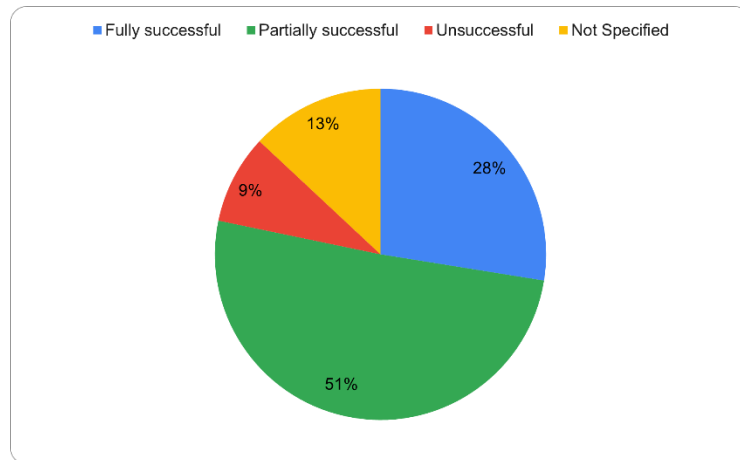


Figure 2.4 Summary results of the effectiveness of the technology-based mental health interventions

Table 2.5 Summary results of the effectiveness of the technology-based mental health interventions

Outcomes	Studies	Total
Fully successful	[62], [192], [200], [144], [5], [42], [68], [151], [37], [51], [82], [111], [48], [234], [64], [149], [195], [223], [94].	19
Partially successful	[119], [31], [210], [32], [209], [30], [193], [219], [1], [34], [83], [87], [134], [197], [156], [233], [125], [116], [118], [113], [4], [135], [26], [76], [25], [136], [84], [57], [138], [29], [107], [20], [228], [89], [188]	35
Unsuccessful	[137], [96], [129], [70], [124], [77],	6
not specified	[100], [46], [196], [198], [152], [130], [63], [226], [79],	9

### 2.5.2.3 Dropout-rate in Technology-based Mental Health Intervention

Based on my results, 45 (65%) studies reported the dropout rate of their studies whereas 24 (35%) studies did not mention whether there were dropouts or not. The dropout rate ranges from 1(2%) to 666 (82%) participants. Figure 2.5 shows that out of the total studies that reported dropout rates, 21 (47%) studies reported dropout rates ranging from 2% to 20%, 16 (36%) studies reported dropout rates ranging from 21% to 40%, and 8 (18%) studies reporting dropout rate more than 40%.

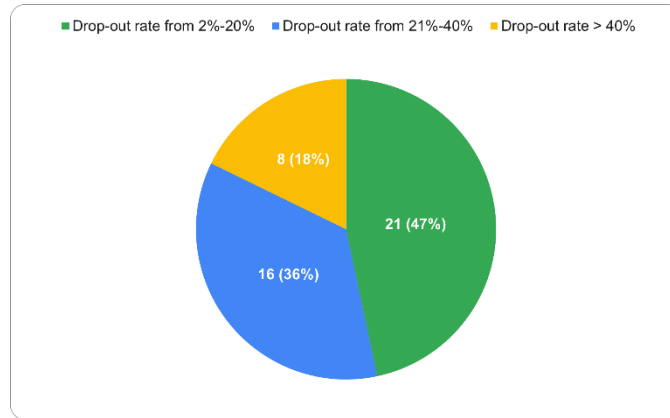


Figure 2.5 Dropout classification based on range of the dropout-rate

#### 2.5.2.3.1 Effectiveness of technology-based mental health and dropout rate

As summarized in Figure 2.6, out of the total studies that reported their effectiveness (see Section 4.2), the unsuccessful studies appeared to have a high mean of the dropout rate of participants ( $M= 135.86$ ,  $SD= 244.54$ ) compared to successful studies (fully and partially successful) which had less mean of the dropout rate of participants ( $M= 32.19$ ,  $SD=60.74$ ). However, the means were not significantly different as determined by the t-test ( $t(6.096) = -1.12$ ,  $p = .306$ ). The studies that have unspecified outcomes had a 3.5 dropout rate mean.

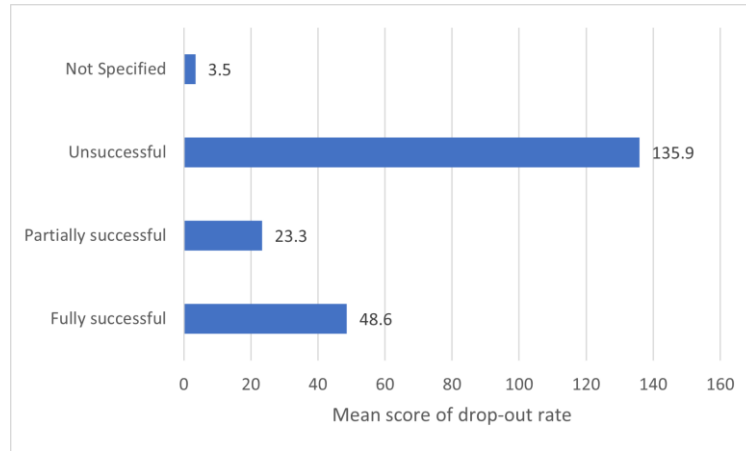


Figure 2.6 Comparative effectiveness of TMHIs by the mean of dropout

### 2.5.2.4 Evidence-based Therapy and Behavior Theory Used to Develop the Technology-Based Mental Health Interventions

This section presents the evidence-based therapies and behavior theories used to develop the TMHIs.

#### 2.5.2.4.1 Evidence-based therapy

Evidence-based therapies refer to therapies that have been examined in “real-world” settings from well-designed and well-conducted research [86]. Evidence-based therapies have been documented to be directly or indirectly effective for mental health and were used to develop the TMHIs’ content. The results show that 56 studies used evidence-based therapy to develop the TMHIs’ content whereas 13 studies did not. As summarized in Figure 2.7, positive psychology exercises (PPE) (e.g., breathing exercises, gratitude) and cognitive behavioral therapy (CBT) are the most practices used to develop the content of TMHIs with 20, and 14 studies respectively. This is followed by mindfulness-based stress reduction (MBSR) and psychoeducation with 10 and 9 studies respectively. The fifth place is acceptance and commitment therapy (ACT) with 4 studies. Temporal model (focus on present) (TM), behavioral activation (BA), and dialectical behavior therapy (DBT) are in sixth place with 3 studies each. Mindfulness-based cognitive therapy (MBCT), stress inoculation therapy (SIT), and transactional model of stress and coping (TMSC) are the least used with one study for each.

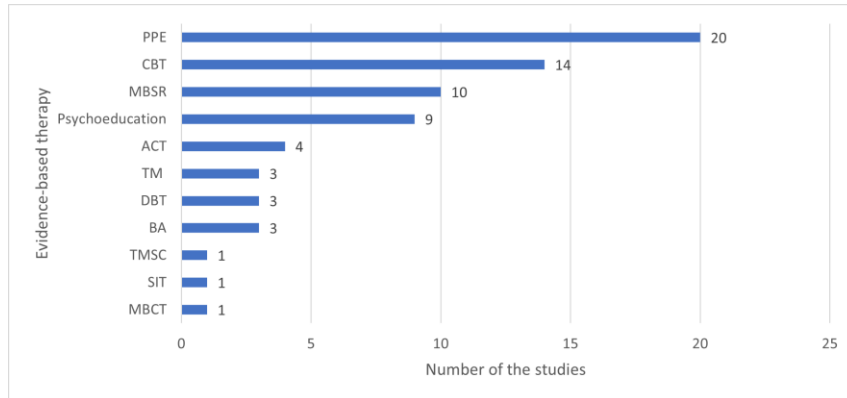


Figure 2.7 Evidence-based therapy used to develop the TMHIs' content

#### 2.5.2.4.2 Effectiveness of technology-based mental health interventions and evidence-based therapy

In general, the studies that employed evidence-based therapies in TMHIs design reported 91% successful outcomes (fully and partially successful outcomes) and 21% unsuccessful and unspecified outcomes whereas the studies that did not employ evidence-based therapies in TMHIs design reported 85% successful outcomes and 15% unspecified outcomes.

I reported the top five evidence-based therapies most frequently used in TMHIs with respect to their effectiveness. As shown in Figure 2.8, out of the total studies that used each therapy (see Section 4.4.1), psychoeducation and ACT ranked first with a total of (100%) successful outcomes (including fully and partially successful outcomes). This is followed by CBT which ranked second with 85%, successful results, and 14% unsuccessful and unspecified outcomes. MBSR and PPE came at third with 70% successful outcomes and 30% unsuccessful and unspecified outcomes.

It is worth noting that some of TMHIs are built based on more than one therapy such as CBT with psychoeducation or PPE with psychoeducation.

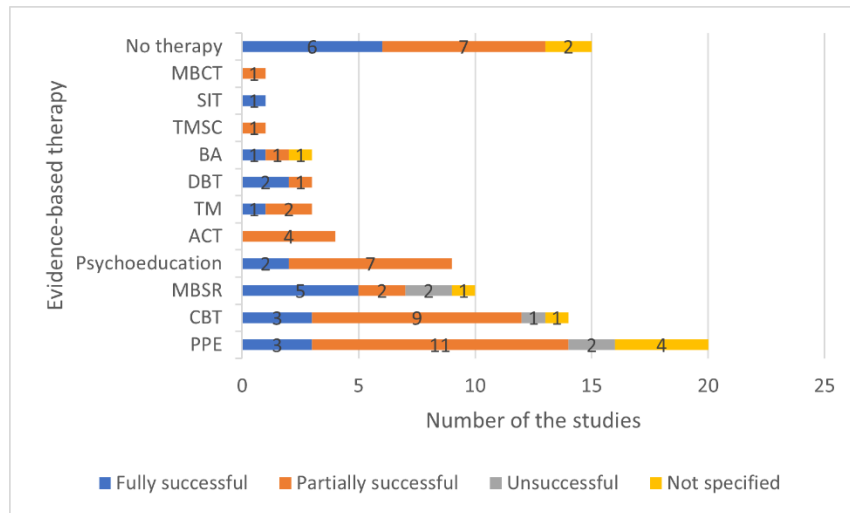


Figure 2.8 Comparative effectiveness of TMHIs by evidence-based therapies

#### 2.5.2.4.3 Behavior theories and their effectiveness

Behavior theories were used to inform the design of in TMHIs. Evaluating the studies based on the behavior theories they employed shows only 3 studies that used behavior theory to inform what type of persuasive strategies were employed in TMHIs. These theories included: self-efficacy theory [87], goal setting theory and self-efficacy theory [116], and self-determination theory [76]. Self-efficacy theory was used in two out of three studies.

With respect to the effectiveness, all 3 (4%) studies that used behavior theory reported partially successful outcomes whereas 66 (96%) studies that did not use behavior theory in TMHIs reported 18(27%) studies full successful outcomes, 33 (50%) studies partially successful outcomes, and 15 (23%) unsuccessful and not specified outcomes (see Figure 2.9).

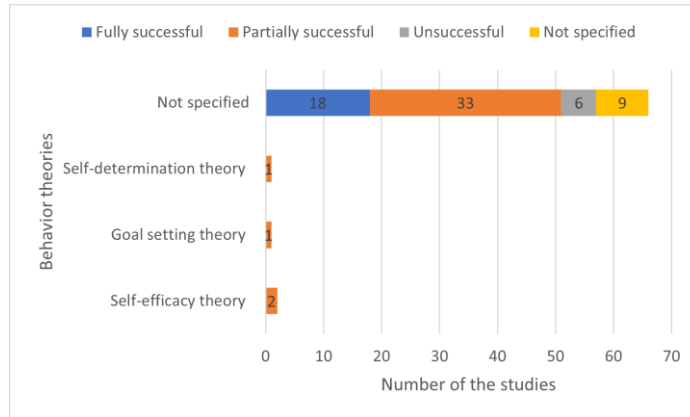


Figure 2.9 Comparative effectiveness of TMHIs by behaviour theory

### 2.5.2.5 Persuasive Strategy Employed in Technology-Based Mental Health Intervention

Overall, I found 27 distinct persuasive strategies used in the design of TMHI’s in the studies reviewed. As shown in Figure 2.10, self-monitoring and feedback (n=53 studies), reminders (n=37 studies), and personalization (n=23 studies) emerged as the most commonly employed strategies in TMHIs. These are followed by suggestions with 19 studies, expertise with 12 studies, and expertise with 12 studies.

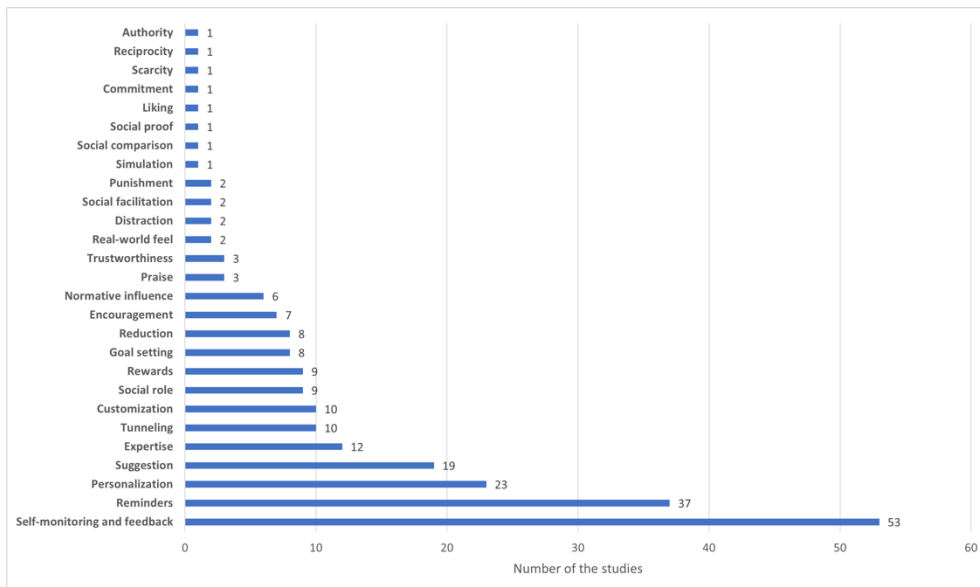


Figure 2.10 Persuasive strategies employed by technology-based interventions for mental health

It should be pointed out that one study did not employ any type of persuasive strategy [188], 14 studies only employed one persuasive strategy out of which 5 studies employed only self-monitoring [31], [79], [113], [219], [32], 5 studies employed only reminder [124], [77], [226], [149], [57], 1 study employed only distraction [223], one study employed only social role [228], and one study employed only personalization [138] and 57 studies employed more than one persuasive strategy.

#### 2.5.2.5.1 Implementation of persuasive strategies

I present the various implementation of some persuasive strategies in TMHIs in this section. Table 2.6 shows the different implementations of persuasive strategies.

Table 2.6 various implementation of persuasive strategies

<b>Persuasive strategy</b>	<b>Implementation</b>
Self-monitoring and feedback	<ol style="list-style-type: none"> <li>1. Self-monitoring and feedback in TMHIs were implemented as being able to track the symptoms or mood by answering a set of questions using multiple-choice options or by using a horizontal slide scale.</li> <li>2. - Tracking thoughts or comments in TMHIs was implemented by allowing users to enter their thoughts, feeling using the text or audio recording.</li> <li>3. There are a few studies that implemented auto-tracking which passively collects sensor or log data including accelerometer, microphone, location, and communication information to infer behavioral and contextual patterns (speech, activity, SMS, and call log ) and location [31], [1], [196], [37].</li> <li>4. The collected information is visualized in a mood dairy [25], [111], mood cloud [84] statistics format [137], [135], [138],</li> </ol>



<b>Persuasive strategy</b>	<b>Implementation</b>
	[151], [134], or graphical feedback [46] (see Figure 2.11), or alongside with contextual information [82].
Reminder	<p>There are various ways that reminders have been implemented in TMHIs which are directly dependent on the technological platforms used in delivering the intervention.</p> <ol style="list-style-type: none"> <li>1. Reminders in the web-based TMHIs were mostly implemented as emails, SMS messages, or phone calls that remind the user to engage with the interventions and perform the behavior such as doing their meditation.</li> <li>2. Reminders in mobile-based TMHIs applications were designed as auditory signals and visual notifications that appear on the mobile screen [100], as a small box that remains visible throughout the day [209], or as a banner that pops up on the phone screen and swiping the banner took users to the app [57].</li> </ol> <p>It is worth noting that most TMHIs that included reminders did not mention how the reminder was implemented.</p>
Personalization	<ol style="list-style-type: none"> <li>1. Based on users' self-ratings of the issue, the app provides suggestions on how to manage their mental health issues and support statements in written text with images, audio clips, or videos [100]. Moreover, the interventions' content is personalized based on user data collected in survey questions [5] [129], [82], the app check-in assessment [125], users' symptom profile [29], and user's input mood [136] or by continuously asking to select among different response options [83].</li> </ol>

<b>Persuasive strategy</b>	<b>Implementation</b>
	<ol style="list-style-type: none"> <li>2. when users report their mental health problems or select from menu listing problems, the app guides the user through the skills [193] or suggests activity [26] that is most likely to be relevant to the user's particular issue at that moment.</li> <li>3. Based on the user's data, the therapist/supporter provides personal guidance and encouragement to keep using the program [62]. Also, they can send short text messages to the user through the messaging system to support them [137].</li> <li>4. Based on the user's progress in the app, the app sends personalized messages to remind the user of his/her goals, and skills he/she has acquired [200]. Based on the unusual mood of users, a message would pop up to suggest activities that may help[37].</li> <li>5. By analyzing users' facial expressions and the sentiment of their SMS messages, the app provides users with content that encourages them and increases their engagement [96].</li> <li>6. The user receives personalized feedback at each stage of the intervention [87], or personalized video feedback based on the user's progress [197].</li> <li>7. The user's goal difficulty is modified based on the user's immediate previous performance [116].</li> </ol>
Suggestion	<p>Most TMHIs studies that employed suggestions strategy in the design of their intervention did not specify how it was implemented. Only a few studies reported their implementation of the suggestion strategy.</p> <p>1- The suggestions strategy was designed in a form of screen sequences containing mental health issues management</p>

<b>Persuasive strategy</b>	<b>Implementation</b>
	<p>suggestions [30] or as a menu that has a list of suggestions on how to manage mental health issues or how to do mindfulness in daily activities. [65], [62].</p> <p>2- Suggestions can appear as a pop-up message on the phone to suggest doing a task or an activity such as breathing if the user self-reported a negative mood or is unwilling to use the interventions [37].</p>
Expertise	<p>In all TMHIs studies that employed expertise strategy in their design, they implemented expertise strategy as a psychoeducational video of an expert narrator such as Marsha Linehan, the inventor of DBT [200].</p>
Rewards	<p>TMHIs provide rewards in various forms. Some TMHIs studies provide rewards in form of points [48], [130], [195], [200], badges [1] [130], j, token [20], and a virtual rose [4]. Only 2 TMHIs studies implemented rewards by allowing users to unlock more content (such as more activities [62], or more meditation sessions [200]) as a way of rewarding users for behavior or task performance.</p>
Customization	<p>Customization was employed in TMHIs by allowing users to incorporate their music, photos, and contacts in the app [119], create their activity [1] and toolkit [94], custom reminders [144], and the layout of the app [62], [63], choose their avatar [200], [131] and their favorite icon set [76], add new values and behaviours in the app [135].</p>
Normative influence	<p>In all TMHIs studies that employed normative influence in their design, they implemented it as a means for social interaction in the</p>

<b>Persuasive strategy</b>	<b>Implementation</b>
	<p>form of community forums where users can communicate anonymously with other users in the system.</p> <p>1- Users can respond anonymously to another user's content by "like" and showing how many users liked it [62].</p> <p>2- The forum allows no threads to make it simple for the users, users are allowed to choose a nickname to use the forum, and posts are ordered from most recent to least recent [70].</p>
Social facilitation	Users can see other people’s recent behavior by clicking on either value or behaviours [135].
Praise	Praise was employed in TMHIs as encouragement words (i.e., “You are doing great”, “That's good news”) [192], [200], [134].
Punishment	<p>The punishment was implemented in the form of a flame that turns off when users are not able to relax, and users must start over [20].</p> <p>It is also implemented as a bar that turns to red if users missed the target [1].</p>
Tunneling	<p>1- Tunneling was implemented in TMHIs in the form of guidance on how to use the app to achieve a specific activity in line with the desired mental health outcome (e.g., how to meditate) [89], [134], [42].</p> <p>2- It was also implemented in the form of guidance for user on what the next module or activity that he/she needs to do by numbering their order (see Figure 2.12), or sending a hyperlink to their e-mail [64], [151], [87], [156], [233], [29], [4].</p> <p>3- It was implemented as a cat avatar that guides the users through the challenges and self-reporting</p>

<b>Persuasive strategy</b>	<b>Implementation</b>
Social comparison	The social comparison was employed as Leaderboard [48]
Social proof	Social proof was employed as a message that users receive to encourage the completion of a higher number of activities “Congratulations! Most participants have completed all 5 activities on Day 1! How many will you complete today?” [48].
Liking	Liking was employed as a message that users receive “You are amazing and are making great progress completing acts of kindness! This cute puppy asks you to complete all 5 activities today!” [48].
Commitment	The commitment was employed as a message that users receive “You have already completed many activities until now and are in the Top 5 Leaderboard! Let’s see if you can keep up or improve your performance and complete all 5 activities today!” [48].
Scarcity	Scarcity was employed as a message that users receive “There are not many chances left to complete all 5 activities. Will, you complete all of them today?” [48].
Reciprocity	Reciprocity was employed as a message that users receive “If all participants complete 150 activities today, everyone will receive 50 extra points!” [48].
Authority	Authority was employed as a message that users receive every day “Did you know? Experts suggest taking part in at least 5 kinds of activities a day. Will you complete all 5 activities today?”.

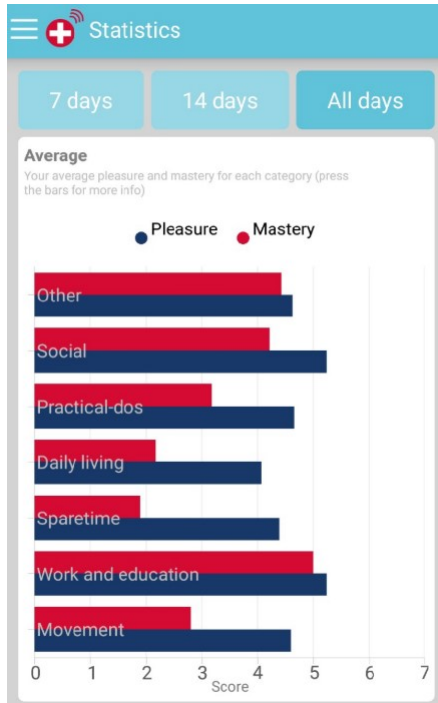


Figure 2.11 collected data is visualized in graphical format (feedback strategy) [46]

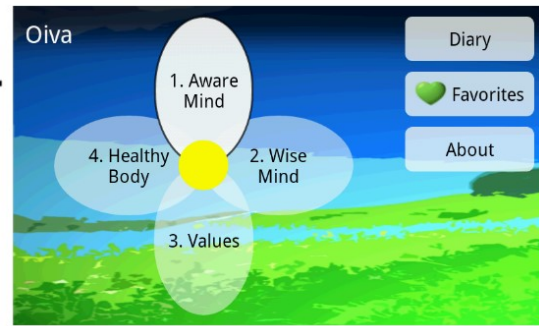


Figure 2.12 Activities are numbering by their order (Tunneling strategy) [2].

#### 2.5.2.5.2 Effectiveness of technology-based mental health and persuasive strategies

Table 2.7 and Figure 2.13 indicate that TMHIs employing some strategies tend to be more effective than others, showing there is possibly a relation between the strategies employed and the effectiveness of TMHIs. However, I reported the top ten persuasive strategies most frequently used in TMHIs with respect to their effectiveness. As shown in Table 2.7 and Figure 2.13, out of the total studies that implemented each persuasive strategy (see Section 4.5), Tunneling and expertise strategies ranked first with a total of (100%) successful outcomes (including fully and partially successful outcomes). This is followed by rewards and customization, which ranked second and third with 92%, and 91% successful results, respectively. Social role and reduction came at fourth with 89% successful outcomes each. Suggestion ranked at fifth with 84% successful result. Finally, the top three most commonly employed strategies in TMHIs self-monitoring and feedback, reminder, and personalization ranked the least regarding effectiveness with 78%, 76%, and 79%

successful outcomes respectively. However, this is possible because they are employed in more studies than others.

Table 2.7 Comparative effectiveness of TMHIs by persuasive strategies

<b>Persuasive strategies</b>	<b>Fully successful studies</b>	<b>Partially successful studies</b>	<b>Unsuccessful studies</b>	<b>Not specified studies</b>	<b>Total</b>
Self-monitoring and feedback	[62], [192], [200], [144], [5], [42], [68], [151], [37], [51], [82], [111], [48], [234]	[119], [31], [210], [32], [209], [30], [65], [193], [219], [1], [34], [83], [87], [134], [197], [156], [233], [125], [116], [118], [113], [4], [135], [26], [76], [25], [136], [84]	[137], [96], [129], [70]	[100], [46], [196], [198], [152], [130], [63], [79],	53
Reminders	[200], [144], [5], [42], [64], [68], [151], [37], [51], [82], [149], [48], [234]	[209], [30], [83], [87], [197], [233], [125], [116], [118], [26], [76], [25], [136], [57], [32],	[96], [124], [77], [129], [70]	[100], [196], [152], [226]	37

<b>Persuasive strategies</b>	<b>Fully successful studies</b>	<b>Partially successful studies</b>	<b>Unsuccessful studies</b>	<b>Not specified studies</b>	<b>Total</b>
personalization	[62], [200], [5], [37], [82]	[193], [138], [34], [83], [87], [197], [29], [107], [125], [116], [135], [26], [136],	[137], [96], [129]	[100], [196]	23
Suggestion	[62], [192], [42], [68], [151], [37], [82], [195]	[193], [34], [233], [107], [125], [135], [136], [30]	[137]	[100], [63],	19
Rewards	, [62], [200], [195], [48]	[20], [209], [1], [4],		[130]	9
Expertise	[200], [42], [68], [111], [94]	[87], [197], [156], [29], [4], [136], [118]			12
Customization	[62], [200], [144], [94]	[119], [1], [83], [135], [76],		[63],	10
Tunneling	[42], [64], [151]	[87], [134], [156], [233], [29], [89], [4]			10



<b>Persuasive strategies</b>	<b>Fully successful studies</b>	<b>Partially successful studies</b>	<b>Unsuccessful studies</b>	<b>Not specified studies</b>	<b>Total</b>
Social role	[62], [200], [5], [64], [94]	[83], [228], [136]	[96]		9
Reduction	[200], [37], [111], [195]	[233], [4], [135],		[198]	8
Goal setting	[200], [195], [48]	[119], [210], [34], [116]		[196]	8
Encouragement	[151]	[30], [134], [197], [76]	[137]	[100],	7
Normative influence	[62], [195] [48]	[107], [76]	[70]		6
Praise	[192], [200]	[134],			3
Trustworthiness	[64], [94]	[89]			3
Punishment		[1], [20]			2
Real-world feel		[197], [156]			2
Distraction	[223]	[210]			2
Social facilitation		[87], [135]			2
Simulation				[46],	1
Social comparison	[48]				1
Social proof	[48]				1

Persuasive strategies	Fully successful studies	Partially successful studies	Unsuccessful studies	Not specified studies	Total
Liking	[48]				1
Commitment	[48]				1
Scarcity	[48]				1
Reciprocity	[48]				1
Authority	[48]				1

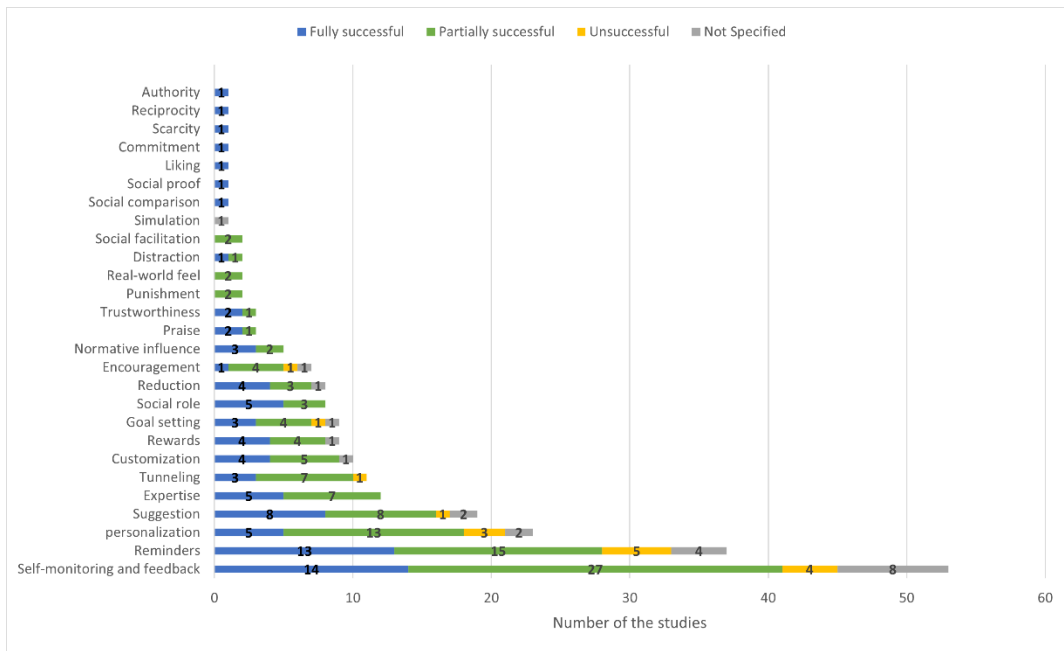


Figure 2.13 Comparative effectiveness of TMHIs by persuasive strategies

#### 2.5.2.5.3 The relationship between the effectiveness and the number of persuasive strategies

With respect to the number of persuasive strategies in TMHIs and their effectiveness, I found that of the 13 studies that employed one strategy, two studies reported unsuccessful outcomes [124], [77](both employed only reminder), and two studies reported unspecified outcomes (self-monitoring [79], reminder [226].) and 9 studies reported successful outcomes (either fully or partially).

To examine whether there is a relationship between the number of persuasive strategies employed in the TMHIs design and the TMHIs effectiveness, I performed Pearson’s correlation between the TMHIs effectiveness and the number of persuasive strategies. The results show that there is a weak correlation between the number of persuasive strategies and the TMHIs effectiveness;  $r = .306$  (weak correlation),  $n = 69$ , and  $p = 0.01$ . So, there is a significant correlation between the number of persuasive strategies and TMHIs effectiveness, but this correlation is weak.

### 2.5.2.6 Delivery Mode of Mental Health Intervention

Based on my findings, the technology platform used to deliver mental health interventions to the users falls under five categories: mobile applications, website interventions, and social networks, both mobile applications and website interventions, and wearable and the mobile neurofeedback system. As shown in Figure 2.14, a significant number of the studies (38 studies) were mobile applications followed by website interventions and social networks (24 studies). Six studies were delivered both as a mobile application and website intervention. There was only one study that was delivered via a wearable and mobile neurofeedback system. It should be noted that 6 studies involved therapist or coach supports during the TMHIs use [219], [192], [144], [5], [134], [200]. Table 2.8 presents various classifications of mobile applications based on their main functions.

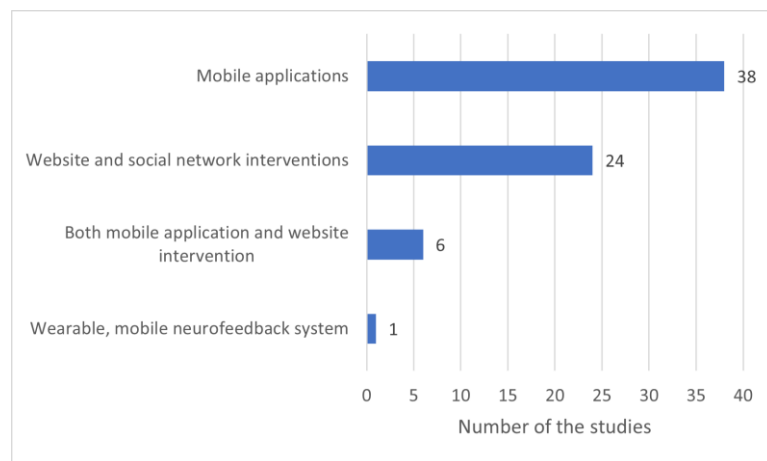


Figure 2.14 Technology platform used to deliver mental health interventions

Table 2.8 Common classification of reviewed mobile applications for mental health

<b>Classification Based on Main Functionality</b>	<b>studies</b>	<b>Description</b>
These applications (apps) are designed for the early identification of warning signs that are associated with increased risk for mental health issues	[31], [32], [1].	The app allows users to answer momentary assessment digital self-report questionnaires for “active” assessment. Each question shows on a single screen with touchscreen response buttons underneath. When a user chooses and taps on a response, the next question shows on a new screen. The system also gathers multimodal behavioral sensing (physical activity, geospatial activity, and speech frequency and duration) and device use data (telecommunication, app use, and phone unlock) continuously [31].
IA-based Chatbot apps are designed to help users to develop positive self-expression learn and practice some strategies.	[94], [136], [96].	The app is a fully automated conversational agent and uses a user interface (UI) that is similar to a text messaging app. The conversations are focused on insights, strategies, and activities related to the field of positive psychology which help the user reflect upon, learn and practice these small strategies and behaviours. The user can reply via writing comments or picking elements either from a list or from a fixed set of reply options [136].
These apps are designed to track users’ data (e.g., mood, thought) and provide users	[79], [152], [63], [130], [200],	The app consists of mood reporting scales and mobile therapies. The mood reporting scales included the Mood Map and single-dimension mood scales for happiness, sadness, anxiety, and anger. All scale entries were made via the touch screen. The app logs the time and date of all

<b>Classification Based on Main Functionality</b>	<b>studies</b>	<b>Description</b>
with the information and instructions they need to practice.	[25], [137], [138]	user interactions. When a user places a fingertip on the appropriate location on the Mood Map, a red dot appears to indicate the user's mood at the time of the experience. Users are prompted for reporting their moods. Once participants recognized their moods, they could access the mobile therapies [152].
Based on the user's assessment or problem that the user report, the app directs the user to specific coaching or provides them with strategies, suggestions, and skills that are tailored to what the user report.	[100], [30], [193], [192], [26]	The DBT Coach app contents from all four modules (mindfulness, distress tolerance, emotion regulation, and interpersonal effectiveness skills). The initial screen of the app assesses pre-Coach distress and urges to harm oneself using a horizontal slide scale. By clicking on the "Begin Session." button, a list of five problem categories and the option to directly select the skill they wanted to use is displayed. Based on user selection, the app guides the user to the skill most likely to be relevant to their particular situation at that moment. If the skill does not help the user, further coaching is provided before being redirected to either the main menu or ending the session. At the end of the session, the app again asks the user to rate distress and urges to harm oneself, and the helpfulness of the session [193].

2.5.2.6.1 Effectiveness of technology-based mental health interventions based on delivery mode  
 Figure 2.15 demonstrates the effectiveness of TMHIs concerning the type of platforms used in delivering them. Of the 38 studies employing mobile applications, I found that 27 studies reported successful results; that is, 19 studies with partially successful and 8 studies

with fully successful results. However, 4 studies reported unsuccessful outcomes and 8 studies did not report outcomes regarding the effectiveness of their TMHIs. For the website and social networks, out of 24 studies delivered via this platform, 7 studies reported fully successful results, 14 studies showed partially successful outcomes, and only 3 studies were not successful. The studies that used both mobile applications and websites for delivering the mental health intervention, all reported successful outcomes. Precisely, 4 studies were fully successful, and 2 studies were partially successful. There is only one study that used a neurofeedback system and it reported partially successful outcomes. The interventions that involved a therapist or coach for support reported successful results (4 fully successful outcomes and 2 partially successful outcomes).

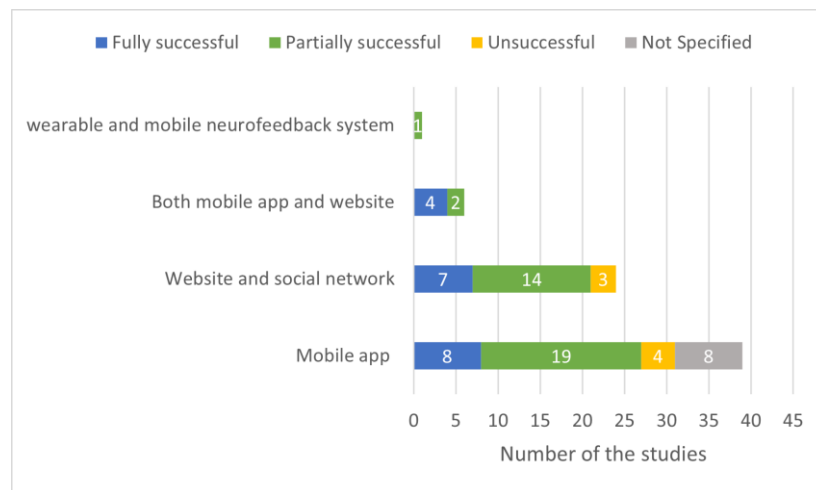


Figure 2.15 Comparative effectiveness of TMHIs by platform

### 2.5.2.7 The Target Issues of Technology-Based Mental Health Interventions

The results show that 44 TMHIs target a specific mental health issue whereas 28 mental health interventions target a combination of mental health issues. As presented in Figure 2.16, a significant number of the included studies addressed stress (n=25), mental well-being and happiness (n=24), and depression (n=20) followed by anxiety (n=11). Furthermore, some studies use TMHIs for general mental health issues (n=8) such as managing worry, mood, sleep quality and so on, self-harm/self-injury (n=4), post-traumatic stress disorder (PTSD) (n=3), substance abuse (n=2), borderline personality disorder (BPD) (n=2), and bipolar disorder (BD) (n=2). It is worth mentioning that some

studies investigated other issues along with mental health problems such as work/class productivity, engagement, and adherence.

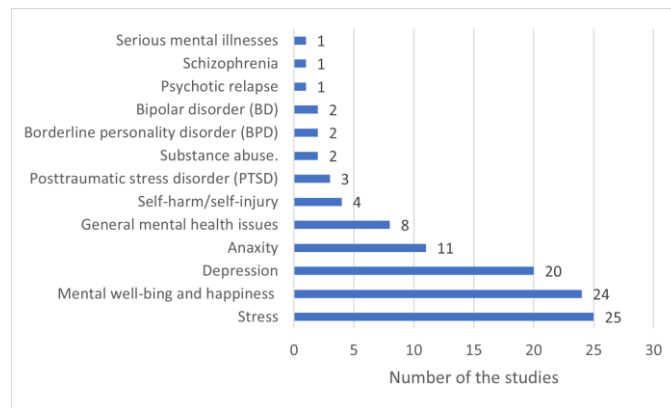


Figure 2.16 Mental health targeted by TMHIs

## 2.5.2.8 The Study Method Used by Technology-Based Mental Health Interventions

### 2.5.2.8.1 Data collection and study design

Table 2.9 summarizes the methodology employed by the reviewed papers. I found that the quantitative method emerged as the dominant method used in evaluating the effectiveness of TMHIs. Of all the studies, 39 studies employed the quantitative method in their study. The most commonly used approach for gathering quantitative data was a questionnaire/survey and a few studies collected additional quantitative data via logged data of user's behavior and system usage. This is followed by studies employing the mixed methods approach; combining both quantitative and qualitative approaches, used in 28 studies. Only two studies used a fully qualitative method which is the least popular method of evaluating TMHIs. Interviewing is the most commonly used qualitative method in the reviewed papers. With respect to randomized controlled trials (RCT) and using a control group to evaluate the TMHIs, I found that 42 studies employed RCT whereas 36 studies did not. Furthermore, 35 studies included a control group and 34 did not include a control group for comparison with the intervention group. Of all the 35 studies that included a control group, 21 studies used a waitlist control group (WLC) (a group of participants who do not receive the intervention during the experiment, but who are put on a waiting list to

receive the intervention after the active experimental group is done), whereas 14 studies out of 35 involved an active control group. The active control group receives another intervention, face-to-face treatment, or the same intervention of the experimental group with some alteration.

#### 2.5.2.8.1.1 Effectiveness of technology-based mental health interventions based on data collection and study design

As Table 2.9 and Figure 2.17 explain, out of the 39 studies that used a quantitative approach for evaluation, 10 (26%) reported fully successful outcomes, 25 (64%) reported partially successful outcomes, and 4 (10%) reported unsuccessful and unspecified outcomes. However, of the studies that used the mix of the quantitative and qualitative evaluation approach, a total of 9 (31%) were fully successful, 10 (38%) were partially successful, and 9 (31%) were unsuccessful and not specified. The two studies which used only a qualitative approach reported unsuccessful and unspecified outcomes.

With respect to RCT, out of the 42 studies that employed RCT, 7 (16%) reported fully successful outcomes, 20 (49%) reported partially successful outcomes, and 6 (14%) reported unsuccessful and unspecified outcomes. However, out of the 38 studies that did not use the RCT, a total of 12 (34%) were fully successful, 15 (42%) were partially successful, and 9 (24%) were unsuccessful and not specified (see, Table 2.9 and Figure 2.18). These results show that there are no differences between the studies that used the RCT approach and others that did not regarding the effectiveness of TMHIs.

With respect to a control group, out of the 14 studies that employed an active control group, 3 (24%) reported fully successful outcomes, 9 (65%) reported partially successful outcomes, 2 (12%) reported unsuccessful and unspecified outcomes whereas out of the 21 studies that employed a WL control group, 5 (23%) reported fully successful outcome, 13 (64%) reported partially successful outcomes, 3 (14%) reported unsuccessful and unspecified outcomes. However, out of the 34 studies that did not include a control group, a total of 11 (32%) were fully successful, 13 (38%) were partially successful, and 10 (29%) were unsuccessful and not specified (Table 2.9 and Figure 2.19).



Table 2.9 Study methodologies used by technology-based mental health interventions

	<b>Studies with Successful outcomes</b>	<b>Studies with Partially successful outcomes</b>	<b>Studies with unsuccessful /unspecified outcomes</b>	<b>Total</b>	
Data Collection	Quantitative	[223], [192], [5], [42], [64], [51], [111], [149], [195], [234],	[119], [31], [210], [32], [219], [1], [138], [34], [83], [134], [156], [197], [233], [29], [107], [125], [116], [118], [113], [89], [26], [25], [57], [84], [188]	[79], [137], [124], [77],	39
	Qualitative			[100], [198],	2
	Mixed methods	[62], [200], [144], [68], [151], [37], [82], [48], [94],	[209], [30], [193], [20], [87], [228], [4], [135], [76], [136],	[46], [196], [96], [129], [152], [70], [130], [63], [226],	28
RCT	Yes	[5], [64], [68], [151], [51], [149], [195],	[119], [31], [210], [209], [138], [34], [83], [87],	[100], [137], [77], [129], [70], [226],	42

	<b>Studies with Successful outcomes</b>	<b>Studies with Partially successful outcomes</b>	<b>Studies with unsuccessful /unspecified outcomes</b>	<b>Total</b>
		[134], [156], [197], [228], [29], [125], [113], [89], [76], [136], [84], [188]		
No	[223], [62], [192], [200], [144], [42], [37], [82], [111], [48], [94]. [234],	[32], [30], [193], [219], [1], [20], [233], [107], [116], [118], [4], [135], [26], [25], [57]	[96], [79], [46], [196], [198], [124], [152], [130], [63],	36
Active	[223], [68], [51],	[138], [87], [197], [29], [116], [89], [76], [57], [188]	[137], [226],	14
Control group	[5], [42], [64], [151], [195],	[119]. [210], [209], [20], [34], [83], [134], [156], [228], [233], [113], [136], [84]	[124], [77], [129],	21
WLC				

	<b>Studies with Successful outcomes</b>	<b>Studies with Partially successful outcomes</b>	<b>Studies with unsuccessful /unspecified outcomes</b>	<b>Total</b>
No control group	[62], [192], [200], [144], [37], [82], [111], [149], [48], [94], [234],	[31], [32], [30], [193], [219], [1], [107], [125], [118], [4], [135], [26], [25],	[100], [79], [46], [196], [96], [198], [152], [70], [130], [63],	34

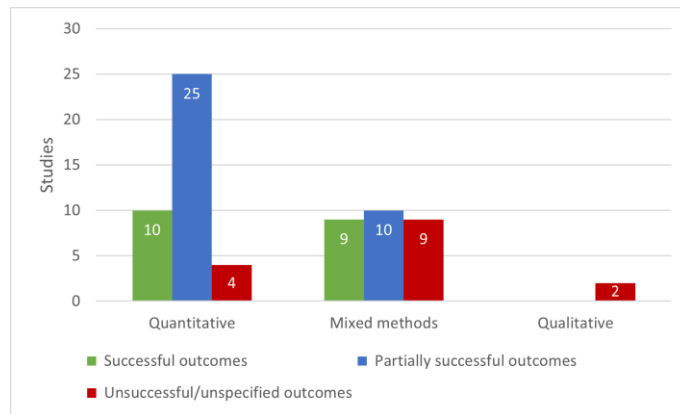


Figure 2.17 Comparative effectiveness of TMHIs by data collection

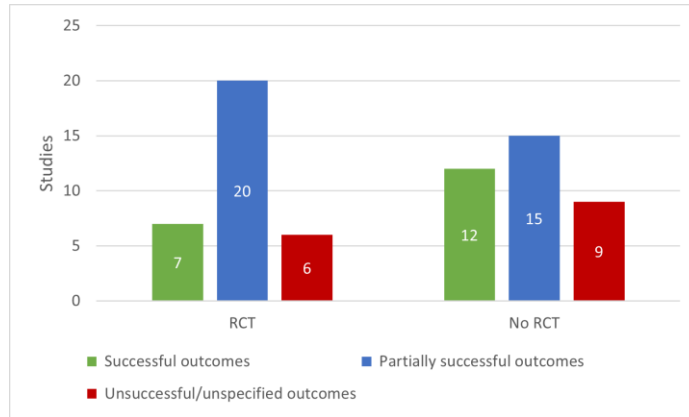


Figure 2.18 Comparative effectiveness of TMHIs by conducting RCT

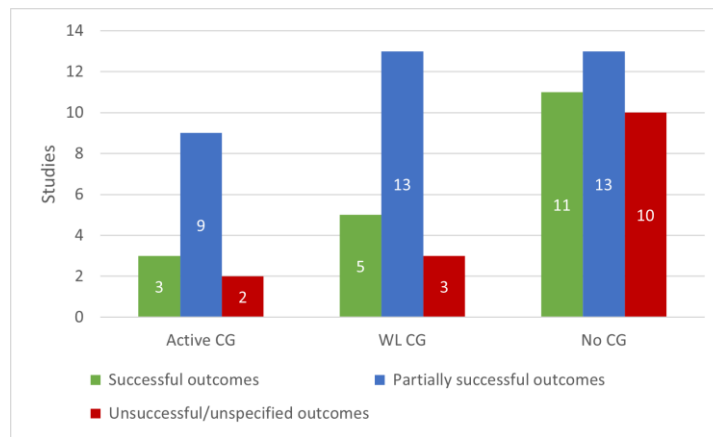


Figure 2.19 Comparative effectiveness of TMHIs by including control group (CG)

### 2.5.2.9 Duration of Evaluation

Regarding how long the TMHIs were evaluated, I found that the duration of evaluation varied substantially, ranging from 25 minutes to 14 months. As shown in Figure 2.20, more than half reviewed studies 37 (54%) evaluated the TMHIs from 1 month to 3 months, 20 (29%) studies for less than one month, and 10 (14%) studies from 3 months to 6 months and two (3%) study from 6 months to a year. In the majority of the studies, 52 (75%) did not conduct a follow-up study after the original study in order to see if the intervention was still effective. Consequently, it is difficult to establish the long-term effects of TMHIs from reviewed studies.

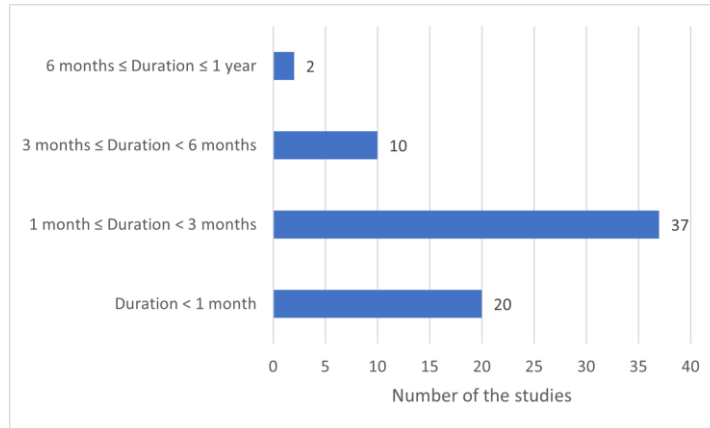


Figure 2.20 Duration of evaluation

#### 2.5.2.9.1 Effectiveness of technology-based mental health interventions based on duration

As Figure 2.21 explains, out of the 20 studies that evaluated the TMHIs for less than a month, 11(55%) studies reported fully successful outcomes, 5 (25%) reported partially successful outcomes, and 4 (20%) reported unsuccessful and unspecified outcomes. Of the 37 studies that evaluated the TMHIs between a month and less than three months, a total of 19 (51%) were fully successful, 13 (35%) were partially successful, and 5 (31%) were unsuccessful and not specified. Moreover, out of the 10 studies that evaluated the TMHIs between three months and less than six months, 6 (60%) studies reported fully successful outcomes, 3 (30%) reported partially successful outcomes, and 1 (10%) reported unsuccessful and unspecified outcomes. Finally, only two studies that evaluated the TMHIs between six months and less than one year reported fully successful outcomes.

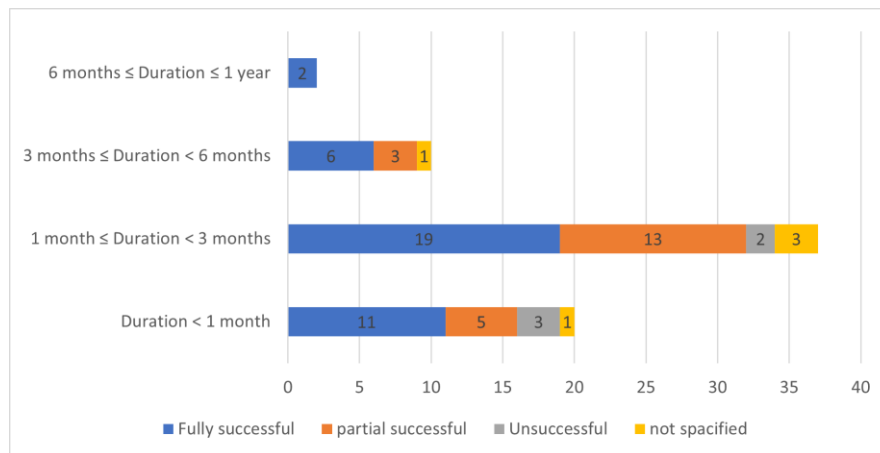


Figure 2.21 Comparative effectiveness of TMHIs by duration

### 2.5.2.10 Study Participants and Sample Size

Similar to the study duration, the sample size (number of participants in the evaluation of the TBMHIs) also differed greatly. The sample size ranges from 1 to 855 participants, with a mean sample size of 155 ( $SD=202.2$ ) participants. However, one study was conducted in stages with a sample size that was varied at each stage [100]. In such cases, I report a combined sample size from all stages. The convenience sampling method was the most recruiting method used in most studies to recruit participants from the general population, academic communities, company communities, specific hospitals, or via online forums.

As shown in Figure 2.22, 45 studies are targeted at adults, 17 studies involved young adults, only 5 studies are targeted specifically at children and adolescents and 5 studies did not specify the target audience.

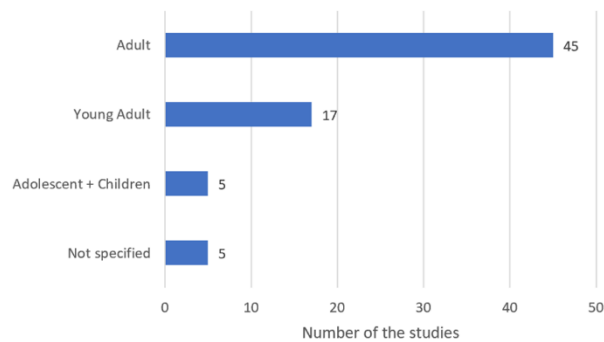


Figure 2.22 Targeted age demographic

### 2.5.3 DISCUSSION

The purpose of this study is (1) to evaluate the effectiveness of TMHIs and the relationship between effectiveness and design strategies employed; (2) to summarize and highlight trends in the effectiveness of TMHIs by dropout rate, employed persuasive strategies, evidence-based therapy, behavior theory employed, the technology platform for delivery, the methodology used; and (3) to uncover pitfalls and gaps in the reviewed paper that could be leveraged and used to inform future TMHIs design.

### **2.5.3.1 Overall Effectiveness of Technology-Based Mental Health Interventions**

Overall, 79% of the articles that I reviewed in this study reported successful outcomes, whether fully or partially successful, which shows that technology-based mental health interventions are effective overall. Only 9% of the reviewed studies reported unsuccessful outcomes. There were no specified reasons for the unsuccessful results of these studies because each study had a different population, targeted different issues, and used a different method, strategies, therapy, and technology platform that may contribute to unsuccessful outcomes. For example, two of the unsuccessful studies [129], [70] highlighted a high dropout of participants, 91% and 82% respectively which could be a reason for the ineffectiveness of the TMHIs. Moreover, three of these unsuccessful studies used mobile applications for delivering the intervention whereas the other three used websites and social networks. Therefore, it is difficult to establish the actual reasons for the ineffectiveness of the TMHIs that reported unsuccessful results. The target audience, their behavior change, and persuasive strategy discrepancy could be other reasons for the ineffectiveness of the TMHIs as reported in [162].

### **2.5.3.2 The Relationship Between Dropout-Rate and the Effectiveness of Technology-Based Mental Health Interventions**

The analysis shows that the unsuccessful studies appeared to have a higher mean of dropout rate of participants ( $M=135.86$ ) compared to the fully successful study ( $M=48.6$ ) and partially successful ( $M=23.3$ ). That means that there is a relationship between the two. This suggests that high dropout could be an early indicator that a TMHI would not be successful. This is probably because users are more likely to quit using a TMHI if they find it not useful or usable with respect to helping them achieve the target mental health goal. Moreover, technology issues and irrelevant and incomprehensible content could be other reasons for users to drop out of an eHealth intervention [127].

### **2.5.3.3 The Relationship Between the Effectiveness of Technology-Based Mental Health Interventions and Persuasive Strategies**

In the present review, various persuasive strategies were identified that were used to achieve positive mental health outcomes. With respect to the studies employing persuasive strategies, and reported successful results, whether fully or partially, I found that tunneling and expertise strategies ranked first with a total of (100%) successful outcomes, followed by rewards and customization, which ranked second and third with 92%, and 91% successful results, respectively. Although self-monitoring and feedback, reminders, and personalization emerged as the most commonly employed strategies in TMHIs, they ranked the least of the top ten persuasive strategies regarding effectiveness. However, this is possible because they are employed in more studies than others.

It is also necessary to highlight the fact that most the TMHIs employed more than one strategy to achieve the targeted mental health outcomes and only 14 studies employed one strategy. There was a weak correlation between the number of strategies and the effectiveness of the TMHIs. This is possible because the effectiveness was based on not only the persuasive strategies employed but also exposure to the interventions' content, the method used to deliver the interventions, the population, and the technology platform. There is a lack of a clear description of how the strategies are implemented in the intervention in reviewed papers. TMHIs' researchers often focused more on the effectiveness of the intervention's content which delivers through these technology platforms more than the technical design aspect (e.g., persuasive strategies).

### **2.5.3.4 The Relationship Between the Effectiveness of Technology-Based Mental Health Interventions and the Technology Platform Used**

Mobile applications were the most dominant technology platform used, with a total of 53% of studies, followed by website and social networks, using both mobile application and website, and wearable and mobile neurofeedback systems, which had a total of 33%, 8%, 4%, and 1% studies respectively. Therefore, it is very clear that the first and most dominant technologies employed in the reviewed studies were mobile applications. This is expected



since it makes it possible for users to track their moods and thoughts and use the interventions within their environment and during critical moments of their daily lives. This corroborates my findings, whereby 78% of the studies that employed self-monitoring and feedback strategies reported successful outcomes (fully and partially), and 76% of the studies that employed reminder strategies reported successful outcomes (fully and partially). These findings suggest that tracking moods, and thoughts in their day-to-day lives and after performing activities and a simple nudge such as a reminder to do these activities (e.g., breathing exercise) could encourage people to improve their mental health. This is understandable, taking into account that people are always busy these days. So, even when they have the good intention to perform some positive activity to improve their mental/emotional health, they can easily forget. For that reason, a simple reminder could encourage users to do their exercise. That explains why the mobile platform is the dominant platform for delivering mental health interventions.

I also found that the studies that used mobile applications reported more successful outcomes compared to the studies that used the website and social networks. It seems that mobile applications are an attractive and promising platform for delivering mental health interventions. Because of their ubiquitous nature, they can easily be used for just-in-time intervention – intervening at the point of need and allowing the implementation of timely strategies.

### **2.5.3.5 The Relationship Between the Effectiveness of Technology-Based Mental Health Interventions and Behavior Theory, and Evidence-Based Therapy**

The results reveal that 96% of the studies reviewed did not use any behavior theory to inform the design of their TMHIs or did not mention the theory employed. Reliance on evidence-based practices and simplicity of the interventions might be the reasons for not using a theoretical basis for health intervention development as reported by [190].

Considering that the majority of the reviewed studies did not use any theory, it is difficult to draw conclusions on the relationship between employing behavior theory and the

effectiveness of TMHIs. However, based on what I have, a total of 66 (96%) of all the studies employing no theory in their TMHIs design 51(77%) studies reported successful outcomes, whether fully or partially successful, while 15 (23%) reported unsuccessful outcomes or did not specify the outcomes. Regarding the studies employing theories (3 studies), all of them reported successful results (fully and partially successful). So, it seems that the use of behavioral theories to inform what type of persuasive strategies are used in TMHI design might enhance the effectiveness of TMHIs in promoting positive mental health and reducing negative ones. Research has shown that interventions based on theory tend to be more effective than those based on the researcher own's intuition [155].

With respect to evidence-based therapy, the results show that 56 ( 81%) of the TMHIs' studies were developed based on evidence-based therapy. Most TMHI's content was built based on positive psychology exercises (PPE) and cognitive behavioral therapy (CBT) with 34% and 24% respectively. The studies that employed CBT and PPE in TMHIs' content reported 67% and 86% successful results, respectively. This is followed by mindfulness-based stress reduction (MBSR) with17% and the studies that employed it reported 70% successful outcomes. Psychoeducation and acceptances and commitment therapy (ACT) were employed in a few studies with 10% and 7% studies respectively. However, the studies that used psychoeducation and ACT reported (100%) successful outcomes (including fully and partially successful outcomes). From my results, it is clear that there is a relationship between the type of evidence-based therapy and the effectiveness of TMHIs.

#### **2.5.3.6 The Relationship Between the Effectiveness of Technology-Based Mental Health Interventions and Study Design**

The results show that most of the studies that used a quantitative approach for evaluation with 35 (90%) studies reported successful outcomes, whether fully or partially successful. However, in the studies that used mixed design, 19 (69%) studies reported successful outcomes, and the only two studies that used a qualitative approach reported all unsuccessful or unspecified outcomes. Moreover, 35 (87%) of studies that included a

control group, whether active or a waitlist (WL) control group, reported successful outcomes more than studies that did not include a control group 24 (71%).

With respect to randomized controlled trials (RCT), the results show that there are no differences between the studies that used the RCT approach and others that did not regarding the effectiveness of TMHIs. However, it should be noted that RCT is used as a way of limiting bias and producing an internally valid impact estimate.

Overall, it is difficult to know whether the positive outcomes are due to the research design or the intervention content, or the type of persuasive strategies employed in the interventions. However, the review results show that TMHIs are a promising approach for promoting desirable mental health outcomes. The review also highlighted that TMHIs trends and limitations of existing studies and suggested some improvements and future research direction.

#### **2.5.4 General Limitations and Recommendations for Future Research**

Based on the results of this review, I identified specific gaps in the literature, and I offer suggestions for improvement and moving the field forward.

Most technology-based mental health intervention (TMHI) studies did not use behavior theories to inform the design of the TMHIs. Reliance on evidence-based practices (e.g. stress management program) and simplicity of the intervention (e.g. meditation reminder) might explain why many designers do not use behavior theories to inform their design of health interventions [190]. Using theories to inform mental health intervention designs can improve their effectiveness at producing the desired outcome. I recommend that future research need to use behavior theories in their design to increase the effectiveness of technology-based mental health intervention and user adherence [155].

There is often a lack of a clear description of how the strategies are implemented in the intervention. Researchers need to provide more details about the technology aspect which could impact the effectiveness of the interventions in their papers. The effectiveness of technology-based mental health intervention may vary not only due to the strategies employed but their implementations.

Another essential point to consider is that most of the reviewed studies employed more than two persuasive strategies in technology-based mental health intervention. This makes it impossible to know which of the employed strategies contributed to the success of the intervention and to which extent. It is still unclear whether persuasive interventions need to employ multiple strategies to be effective. There is a need for future research to investigate the effectiveness of multiple versus single strategy-driven persuasive mental health intervention.

Most of the reviewed studies used a quantitative approach to evaluate the technology-based mental health interventions. This means they lacked qualitative data that could provide more insight into why the interventions are effective (or not) and the causes of dropout. TMHIs researchers need to use more of the mix-method approach in their evaluation to gain more knowledge about the effectiveness of TMHIs and the reason for user dropout [194].

Gaining more insight into what persuasive strategies and functionalities that will be more successful for various contexts before the design is always essential. Thus, it is important for designers to always involve the target audience in their design process [184][15].

Most reviewed studies have evaluated the TMHIs for short time (less than 6 months) and with a limited audience. Therefore, future work should focus on the long-term evaluation of TMHIs to a larger audience. With respect to the demographics of the target audience, most existing TMHIs are targeted at adults, making it difficult to establish their effectiveness in other demographic groups. Thus, there is a need for TMHIs to target diverse demographics such as older adults and children.

Most existing technology-based mental health interventions reviewed in this study are targeted developed countries such as the USA, and the UK. Therefore, there is a need for TMHIs to target the least developed countries[59] since the impact of mental health interventions might vary according to various contextual factors such as culture. A previous study suggested that there is a need to tailor various PTs and their associated strategies based on cultural groups [180].

## 2.6 Chapter Summary

This chapter aims to review the literature on technology-based mental health interventions (TMHIs) to investigate whether intervention characteristics and persuasive design contribute to the effectiveness of the interventions. It provides a detailed systematic review of 69 papers (from 2003 to 2020) to establish the effectiveness of technology-based mental health interventions (TMHIs) for promoting positive mental health and reducing negative ones. The results show that most of the reviewed studies reported successful outcomes, whether fully or partially successful. Thus, the findings suggest that TMHIs can be used to promote mental/ emotional health when combined with the proper persuasive strategy. Furthermore, the study summarizes and highlights trends in the outcomes including system design, research methods, persuasive strategies and implementations, evidence-based therapy, behavioral theories, and employed technological platforms. The most frequently targeted populations are adults and young adults, while the least are children and adolescents. The outcomes of this work clarify that the most effective and commonly employed technology platforms are mobile applications. Furthermore, this chapter shows that the top ten most frequently implemented persuasive strategies in TMHIs are *self-monitoring and feedback, reminder, personalization, suggestions, rewards, expertise, customization, tunneling, social role, and reduction*. Although only three studies employed behavioral theories in their design, they tend to be more effective than those not based on any theory. Finally, I identified the pitfalls and gaps in the literature that could inform the direction of future research in this area.

In this chapter, I presented the results of a systematic review of 69 papers (from 2003 to 2020) to establish the effectiveness of technology-based mental health interventions (TMHIs) for promoting positive mental health and reducing negative ones and identified the top ten most frequently implemented persuasive strategies and their implementations from literature review only. However, there is a need to understand the persuasive strategies integrated into mental health applications (apps) available on App Store and Google Play and how they are implemented to promote mental health. In the next chapter,

I review 103 mental health and emotional well-being apps to identify persuasive strategies and their implementations.

## CHAPTER 3: EVALUATING PERSUASIVE STRATEGIES IN MENTAL HEALTH APPLICATIONS

*Chapter overview:* Chapter 2 highlights the effectiveness of technology-based mental health interventions and identified the persuasive strategies and their implementations derived from the literature review only. This chapter presents the results of reviewing 103 mental health applications (apps) available in both stores (Google Play and App Store) to identify the persuasive strategies and their implementation <sup>2</sup>.

### 3.1 Motivation of this Work

Nowadays, mental health issues have become a major public health challenge. People with mental health issues find it difficult achieving their daily tasks such as work and study [108]. As result, many of them are using digital applications to support their mental health and enhance life quality. More than 10,000 mental health and wellness apps are available for download and use [221] online. The ubiquitous nature of smartphones and other handheld mobile devices are shaping-up users' lifestyles by adding new aspects to the concept of socializing, accomplishing actions, and creating new habits [179]. Therefore, smartphones are attractive platforms for researchers to deliver interventions. Mobile applications (apps) are being used to deliver interventions targeting various health issues [93]. For mental health issues specifically, Roepke et al. [195] and Arean et al.[21] highlighted in their studies that mobile-based mental health intervention made a strong impact on reducing depressed mood. However, they also reported a high rate of drop-out. By applying various persuasive strategies to reinforce, change, or shape users' behavior and/or attitudes, mental health apps can effectively function as support tools that also

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<sup>2</sup> Originally published in **Alqahtani, F.**, Al Khalifah, G., Oyeboode, O., & Orji, R. (2019). Apps for mental health: an evaluation of behavior change strategies and recommendations for future development. *Frontiers in artificial intelligence*, 2, 30.

motivate and stimulate users to keep on using the apps to achieve better mental health. However, the extent to which available mental health apps successfully employed persuasive strategies and how they implement them in their app to achieve their intended objective remains unknown.

### **3.2 The Objective of this Work**

This work aims to achieve three main objectives. First, I review 103 mental health applications and identify distinct persuasive strategies incorporated in them using the Persuasive Systems Design (PSD) model and Behaviour Change Techniques (BCTs). I further classify the persuasive strategies based on the type of mental health issues the app is focused on. Second, I reveal the various ways that the persuasive strategies are implemented/operationalized in mental health applications to achieve their intended objectives. Third, I examine whether there is relationship between apps effectiveness (measured by user ratings) and the persuasive strategies employed.

### **3.3 Methodology**

In this section, I describe the methods used to achieve the study objectives. Specifically, I detailed the app selection criteria and the coding.

#### **3.3.1 Selection of Sample Apps**

I searched on the App Store and Google Play using the keywords “mental health,” “anxiety,” “depression,” “mood,” “emotions,” and “stress.” I also searched using various combinations of the keywords joined using the conjunctions “OR” and “AND.” The search result revealed the initial list of 437 apps (258 apps from App Store and 179 apps from Google Play). For my analysis, I included apps whose main goal according to the app’s description and the demo of the app show that they are targeted at mental health, and apps that have more than five reviews (comments) in total. In other words, apps that fall into any of these categories are excluded: (1) not focused on mental health, (2) had less than five reviews (or comments), or (3) was not in English. In addition, for apps that appeared in both App Store and Google Play, I counted it as one instead of two. After applying the



selection criteria, a total of 103 apps remained and eligible for coding (see Figure 3.1). The following information was also extracted for each eligible app: name, platform (i.e., iPhone, Android, or both), developer, date of the last update, and price (i.e., free, fee-based, and free with in-app purchases—where developers provide a free version and a paid version if users want to upgrade or unlock additional features in the app).

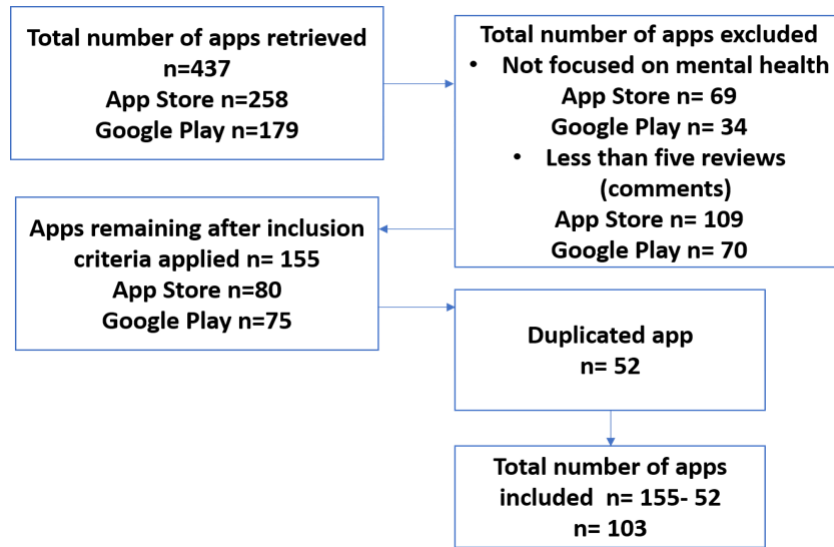


Figure 3.1 Process of selecting mental health apps

### 3.3.2 Coding Apps for Persuasive Strategies

The aim of the coding process in the study is to assess the number and type of persuasive strategies present in mental health apps. Collected apps were coded using both the Persuasive System Design model (PSD) [81] by Oinas-Kukkonen and Harjuma, and Behavior Change Techniques BCTs [150] by Michie and Abraham. I combined and used both the Oinas-Kukkonen and Michie’s frameworks to have a comprehensive list of strategies for deconstructing the apps.

To identify the persuasive strategies employed in the apps and their implementations, a subsample apps (and=5) were downloaded and used for 10 days by two researchers to ensure there is no new strategy revealed during using. After that two researchers independently downloaded and reviewed the 103 apps to identify the persuasive strategies using the PSD model and BCTs. The researchers then met to agree on the initial codes.

For any disagreement that arose between the two researchers, a third researcher was involved to mediate and ensure an agreement is reached. The researchers also classified the persuasive strategies based on the type of mental health issues the app is targeting. Moreover, I also identified the various ways that the persuasive strategies are implemented/operationalized in mental health apps to achieve their intended objectives.

### **3.3.3 Analysis**

To analyze my data, I employed some well-known analytical approaches:

First, I measured the percentage of agreement between two researchers (i.e., before the third researcher was involved). I also calculated interrater reliability, kappa and prevalence and bias adjusted kappa (PABAK).

Second, I conducted descriptive statistics to obtain the mean of persuasive strategies employed in the apps.

Third, I employed independent-samples t-tests to compare the mean of persuasive strategies between free and paid apps and between iPhone and Android apps. Apps that have two versions used on both platforms were not included in the t-test analysis.

Finally, to examine the relationship between the number of persuasive strategies and the effectiveness of apps (as determined by the app ratings), I performed a Pearson's correlation analysis between the number of persuasive strategies and the app's rating.

## **3.4 Results**

I present the detailed results of the analysis in subsequent subsections. I describe the coding agreement, the persuasive strategies employed, their implementations, the target mental health domain, the relationship between the number of strategies employed and app effectiveness.

### **3.4.1 Description of Selected Apps**

I provide a summary of the app's description in Table 3.1. Approximately half (47%) of the apps had been updated within the past year (2018).

Table 3.1A summary description of 103 mental health apps

Price	Free (40 %), fee-based (10 %), Free with in-app purchases (47%)
Developer	Unknown (16%), Commercial (profit Organization) (69%), Government (7 %), NGO (4%), University (5%)
Rating	No rating (7%), 2-2.9 (4%), 3-3.9 (16%), 4-4.9 (67%), 5(4%).
Platform	iPhone (26%), Android (22%), both (49 %).

### 3.4.2 Persuasive Strategies Employed in Mental Health Apps

The results of the analysis show that the percentage of agreement between the two researchers was 86.5%. There was “substantial” agreement: prevalence and bias adjusted kappa (PABAK)=0.71 [39],[123]. Discrepancies were discussed and the coding was refined. Overall, I found 26 distinct persuasive strategies present in the mental health apps reviewed. The number of strategies employed in each app varied and ranges between 1 and 10. However, 14 mental health apps did not employ any persuasive strategies. Interestingly, self-monitoring (n=59), personalization (n= 55), and reminder (n=49) emerged as the most commonly employed strategies (see Figure 3.2). Moreover, I found other strategies that do not exist in PSD/BCT that were employed in the reviewed mental health apps: *Encouragement*, *focus on positive things* and *focus on important things*.

The results of the t-test show that there was a significant difference in the number of persuasive strategies employed within iPhone apps (M= 2.61, SD=1.524) and Android apps (M= 1.74, SD=1.137);  $t(49) = 2.26, p=0.028$ . These results suggest that the number of persuasive strategies employed within iPhone apps is more than Android apps. However, there was no significant difference in the number of persuasive strategies present in free apps (M= 2.38, SD=2.073) and paid apps (M= 2.27, SD=1.104) apps;  $t(101) = 0.868, p = 0.388$ . These results suggest that the number of persuasive strategies present in free apps is the same in paid apps.

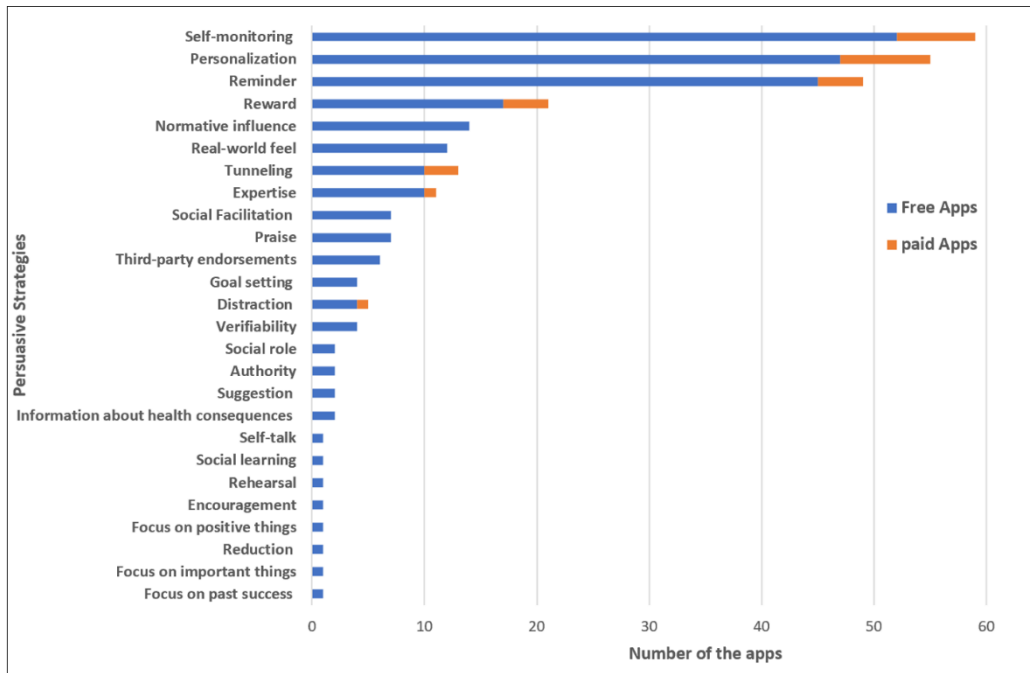


Figure 3.2 Persuasive Strategies Employed by Mental Health Apps Categorized into Free and Paid Apps

### 3.4.3 Persuasive Strategies in Other Health Domains

Comparison of my findings to the findings of earlier reviewed health care apps studies reveals that self-monitoring is one of the common strategies that emerge in chronic arthritis apps [75], alcohol reduction [55], sedentary behavior reduction [71] and promoting physical activities [143]. However, Credibility support strategies were the most strategies implemented in chronic arthritis apps [75] whereas those strategies were absent in most reviewed mobile applications for physical activity [143]. Moreover, reminders were the most implemented strategy in medication management apps for consumers [230]. The results revealed that self-monitoring, personalization, and reminder were the most frequently employed strategies in mental health apps. Some of these studies further reported more strategies that might not frequently be implemented in other health care apps (see Table 3.2 and Figure 3.3).

Table 3.2 Most Strategies Implemented in Reviewed Apps in other Health Domains

<b>Authors</b>	<b>Health domain</b>	<b>model used</b>	<b>Most strategies implemented</b>
Crane et al. [55]	Alcohol reduction	BCTs	self-recording (self-monitoring), information on consequences, feedback on performance
Matthews et al. [143]	promoting physical activity	PSD	self-monitoring
Win et al. [230]	medication management	PSD	Reminder, tailoring, self-monitoring
Gardner et al. [71]	sedentary behaviour reduction	BCTs	setting behavioural goals, social support instruction on how to perform the behaviour, self-monitoring
Geuens et al. [75]	chronic arthritis	BCTs and PSD	surface credibility, expertise, general information, self-monitoring
My results	mental health apps	BCTs and PSD	self-monitoring, personalization, reminder

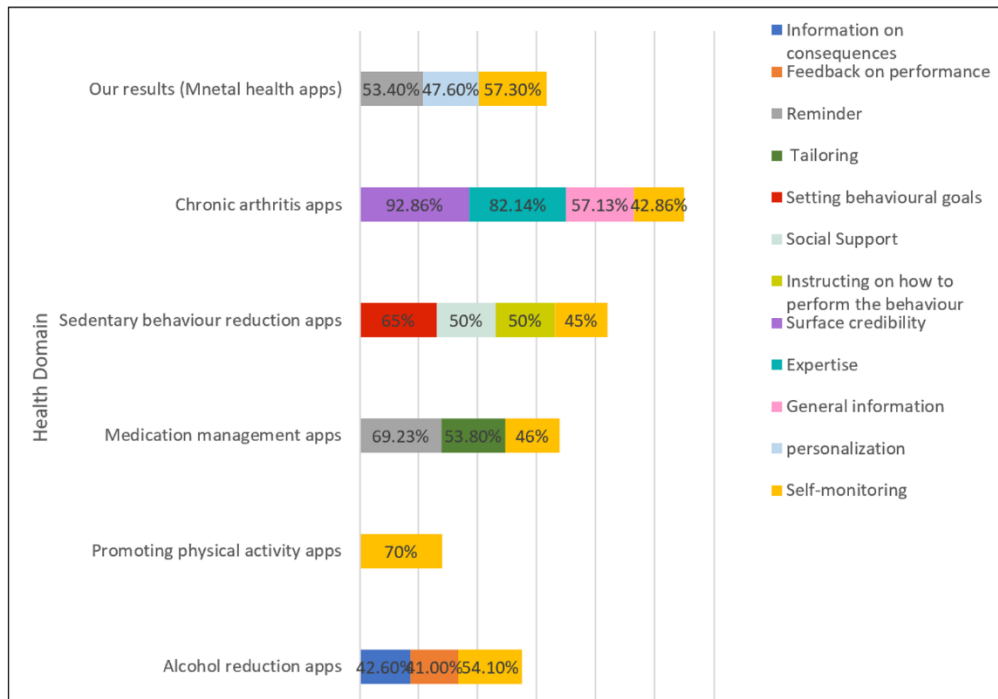


Figure 3.3 Comparative the most strategies implemented in reviewed apps by other health domains

### 3.4.4 Persuasive Strategies and Type of Mental Health Issues Targeted

I examined the persuasive strategies and the type of mental health issues the apps target. The results show that 65 apps target a combination of mental health issues whereas only 38 apps target a specific mental health issue. In general, the apps mostly targeted the following mental health issues: *anxiety*, *stress*, *depression*, and *general mental health* (see Figure 3.4). However, apps that targeted *stress* employed the highest number of persuasive strategies (23 out of 26 persuasive strategies identified in all mental health apps), followed by apps targeting *anxiety* and *depression* employed 20 persuasive strategies. Figure 3.5 presents the overall number of persuasive strategies employed in each mental health issues. The results also show that personalization, self-monitoring and reminder were the most employed persuasive strategies in various mental health apps, see Figure 3.4.

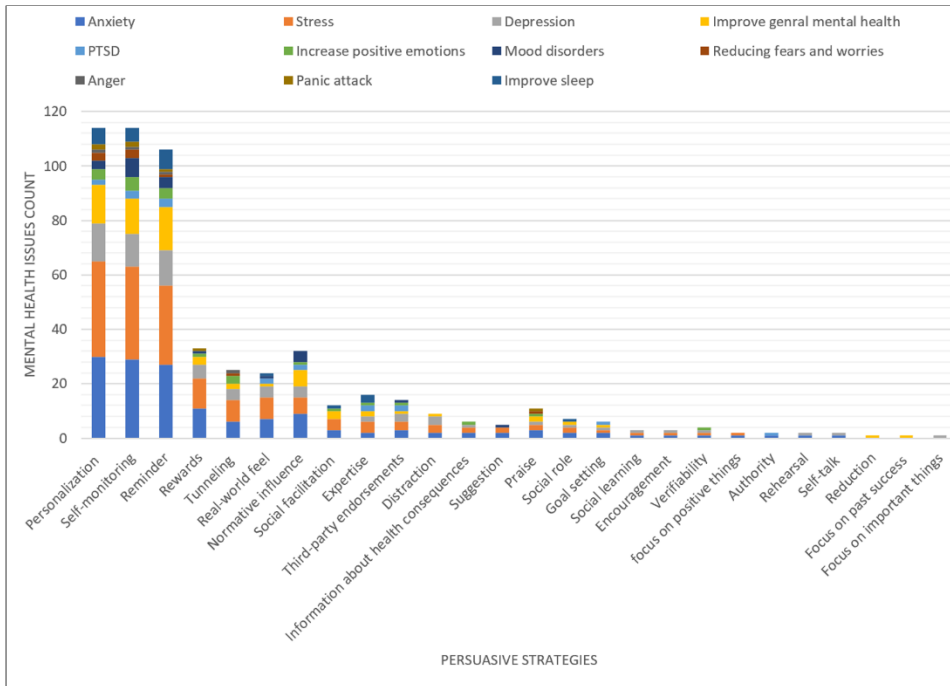


Figure 3.4 Persuasive Strategies for Each Mental Health Issue

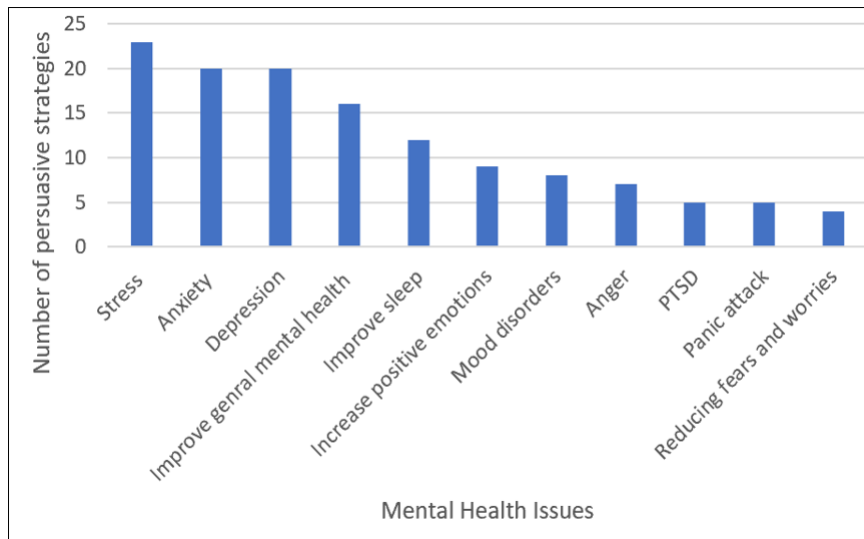


Figure 3.5 Persuasive Strategies for Each Mental Health Issue

### 3.4.5 Implementation of Persuasive Strategies

I present the various implementation of the common persuasive strategies in mental health application in Table 3.3.

Table 3.3 Various implementation of the common persuasive strategies in mental health applications

<b>Persuasive strategy</b>	<b>Implementation</b>
Self-monitoring	This strategy “allows people to track their own behaviours, providing information on both past and current” [175], [169]. In 23 apps, self-monitoring was implemented as being able to review trends of personal data related to mental health in a calendar or graphical format. Moreover, another 29 apps offer self-monitoring as a total number of activities related to mental health improvement performed by an individual and how long they spent on each activity. These include activities such as meditations.
Reminder	This strategy enables a system to remind user to perform the target behavior. Reminder emerged as one of the popular strategies used in mental health apps. It is implemented in 49 mental health apps mainly to remind users to perform an activity (such as meditation, breathing, and assessment) or to track their personal data (e.g. mood). Reminders are often implemented as alert or pop-up boxes and sound.
Rewards	This strategy “offers virtual rewards to users for performing the target behavior” [169]. Mental health apps provide reward in various forms. Some mental health apps provide reward in form of points (6 apps), badges (8 apps), trophies (1 app), insight sticker (1 app), coins (1 app), planet growth (2 apps) and streak (1 app) that could be collected or gained while completing a task such as breathing and meditation. Only 2 apps implemented reward by allowing users to unlock more contents (such as more meditation sessions, or more lessons and activities) as a way of rewarding users.
Praise	This strategy “applauds the user for performing the target behavior via words, images, symbols, or sounds as a way to give positive



<b>Persuasive strategy</b>	<b>Implementation</b>
	feedback to the user” [177]. only 7 apps employed praise as words (i.e. Well Done) (6 apps) and colorful confetti (1 app)
Normative influence	This strategy allows a system to provide “means for gathering together people who have the same goal and make them feel norms” [81]. Normative influence was implemented as a means for social interaction in form of community forums (13 apps) where users can exchange views about issues and feelings or by providing a link to join a Facebook community group (1 app)
Social facilitation	This strategy allows the system to provide a means for discerning other people who are performing the target behaviour [81]. Social facilitation was implemented in the form of community forum of follower and following or listener and listening. Connected people can see each other’s activities; followers can see the activities of the people they are following.
Expertise	This strategy was implemented by showing expertise in the design of the components of the app and knowledgeable in the information provided (11 apps)
Real-world feel	This strategy was implemented by highlighting the people behind the design of the app (12 apps).
Authority	referencing notable organizations who are authority in the area of mental health (2 apps).
Third-party endorsements	This strategy was employed in only 6 apps by providing a logo of respected sources such as a logo of a known university that is behind the app or approved the app.
Verifiability	Moreover, few mental health apps implemented verifiability (4 apps), allowing users to find more information by linking to studies or

<b>Persuasive strategy</b>	<b>Implementation</b>
	reports that provide evidence to support their claim or evidence that informed their design.
Tunneling	This strategy posits that system should guide users through the step-by-step process that lead to the target behaviour by providing means for action that brings them closer to the target behavior. Tunneling was implemented in 13 mental health apps in the form of guidance on how to use the app to achieve a specific activity in line with the desired mental health outcome (e.g. how to meditate and how to breathe properly)
Encouragement	Encouragement was designed as a supportive message, and positive motivational quotes
Focus on Positive Things	Focus on Positive Things was designed, as a game intended to help users learn how to focus on positive words or events as a way of promoting mental health and decreasing negativity
Focus on Important Things	Focus on Important Things was implemented as a game intended to teach users how to focus on important things in users' life and avoid distraction and cognitive overload as a way of promoting mental health
Distraction	Distraction was also implemented as a simple game aimed at diverting user's attention and distracting them from the current (negative) mood.

### 3.4.6 App Effectiveness and Persuasive Strategies Employed

To examine whether there is a relationship between the number of persuasive strategies employed in the app design and the perceived app effectiveness (as assessed by the app

ratings), I performed Pearson's correlation between the app rating and the number of persuasive strategies. The results show that there is no relationship between the number of persuasive strategies and the app effectiveness;  $r= 0.153$  (no correlation) and  $p=0.123$ . So, there is no significant correlation between the number of persuasive strategies and app rating, which demonstrates the perceived effectiveness from the user's point of view.

### **3.5 Discussion**

In this Section, I discuss my findings and offer some design recommendations for mental health app based on my findings.

#### **3.5.1 Persuasive Strategies and Implementation**

The purpose of this study is to identify distinct persuasive strategies incorporated in mobile apps designed to improve mental health and classify the persuasive strategies based on the type of mental health issues the app is focused on. Moreover, the study aims to reveal the various ways persuasive strategies are implemented/operationalized in mental health applications to achieve their intended objectives, and also to examine the relationship between apps effectiveness and the persuasive strategies employed.

Overall, the mental health apps reviewed in this study employed 26 persuasive strategies, a range of 1 to 10 per app. However, 14% of the mental health apps did not employ any persuasive strategies.

Unsurprisingly, I found that self-monitoring is the most prevalent persuasive strategies implemented in mental health apps. According to Bakker et al. [24], self-monitoring is considered the main feature of many evidence-based psychological therapeutic techniques such as cognitive behaviour therapy, mindfulness exercises, emotion-focused therapy, Dialectical behaviour therapy (DBT), and acceptance and commitment therapy (ACT). Self-monitoring help users with mental health issues to manage their conditions. They can track their feeling, thoughts, and behaviours which in turn increases self-awareness and improve mental health outcomes. The apps reviewed in this study limited tracking to manual input. Users with mental health issues need to enter their personal data manually

which indeed is a major limitation. As highlighted by Orji et al. [162], manual recording is tedious, time consuming, and may not work for people with serious mental health issues. Personalization emerged as the second most employed persuasive strategies in mental health apps. According to Price et al. [185], personalizing some aspects of an app such as changing colors, setting backgrounds, and personalizing assessment questions would improve an app's usability. Most importantly, the ability to adjust the intervention delivered via mental health apps to suit the user's needs and characteristics will make the intervention more effective [177]. Moreover, it has been found that personalized health interventions are more effective than the ones employing the one-size-fits all approach in other health domains [167], [170] and in depressive and anxiety disorders specifically [40],[205]. Therefore, the fact that most mental health app incorporated some form of personalization is not surprising considering that even people suffering from the same or similar mental health conditions may have unique needs that require individualized solutions.

Although tunneling and reduction reduces the effort required to achieve the target behavior by guiding the users to perform the task (tunneling) and by simplifying the task (reduction), it was incorporated only in 17 apps and 1 app respectively. This is surprising, considering that individuals experiencing mental health conditions are often required to avoid stressful situations including complicated tasks that may stress them out and worsen their situation. Hence, making it essential that mental health apps are simple enough and also can guide users through the step-by-step process required to achieve the desired behavior is necessary to reduce the tendency of stressing them out when figuring things out themselves. Moreover, according to Alqahtani et al. [12], users with mental health issues complained about lack of guidance when using mental health apps which impair concentration and make them be easily frustrated. Therefore, reduction and tunneling strategy are essential for mental health apps.

The third persuasive strategy present in mental health applications is the reminder strategy. This strategy is mostly designed to remind users to track their personal data or to perform some mental health improvement activities such as meditation and breathing. Although reminders can help to increase adherence and reduce dropout from intervention, it was

only implemented in 49 apps out of 103 apps. However, according to Bakker et al. [24], a lot of annoying reminders can lead to disengagement. Therefore, developers should be careful when designing the reminder in mental health apps to avoid annoying people with frequent and unsolicited reminders. One way to achieve a balance between providing an effective reminder that will encourage users to adhere to the intervention and avoiding unnecessary reminders that will annoy user and make them disengage from the app is to tailor reminders to each individual. Individuals can be allowed to customize not only the frequency at which reminders are sent to them (how often), but also the type of reminder (pop up boxes, text message, sounds etc.) and when it should be sent (time).

Moreover, persuasive strategies such as reward and praise have been found to be among the popular strategies employed in many health apps to motivate users to be more engaged [177]. However, only a few mental health apps implemented reward and praise, although apps for users with mental health issues may benefit from these techniques to motivate users. The reason why reward and praise are not as popular strategies in mental health apps is probably because many designers believe that improving mental health is an intrinsic reward of using their app hence no extra reward is required. Although, improving mental health is a major benefit and the main reason why many people would resort to using the app in the first place, it does not overwrite the need for extrinsic rewards such as badges and points, which have been shown to be effective at engaging users [176]. According to Orji et al., performing health behaviours is often difficult due to lack of immediate tangible benefit [235], offering intermediate rewards such as points and badges, may help to engage the users while they await the intrinsic reward.

The first credibility strategy is *real-world feel* and it is characterized by providing information about people or organization behind the app's content. This was found in 12 apps and still surprisingly low. In addition, 11 apps offered expertise in the design of the components of the app and information provided. I argue that these strategies are very important. All mental health apps, like all health apps, should provide information that is scientifically proven and evidence-based. Possessing the adequate technical skills to be able to develop an app is not enough for designing apps that will effectively improve or support mental health. Unfortunately, only 4 apps implemented the verifiability strategy

which offers a way for users to verify the apps' content, 6 apps employed the third-party endorsements, and 2 apps employed the authority which were very low. Credibility strategies are very important in mental health applications considering the sensitivity of the subject matter. Users need to be assured of not only the effectiveness and reliability of the app contents, but also that their data will be protected (privacy). In the Google store and App stores, anyone can design an app and publish it without providing evidence on the effectiveness of methods used in the app to manage the mental health issues and how users' information is protected. This results in a substantial number of apps that are not perceived as credible and trustworthy.

Social support is an important strategy for users who experience mental health issues because most of them often feel isolated or stigmatized. In this review, I found that only a few apps employed the strategies in the social support category. Only 17 apps employed the normative influence strategy which allow users to share their issues, thoughts, emotions with others to find support.

Certain strategies revealed in this study liken those identified in reviewed applications of other health domains. For example, self-monitoring strategies were similarly highlighted in reviewed applications of medication management apps for consumers [230], chronic arthritis apps [75] and promoting physical activities [143]. Moreover, self-monitoring strategies were specifically highlighted as a promising approach to sedentary behavior reduction [71]. However, it is worth mentioning that there are other strategies that emerge as most employed in the reviewed applications in other health domains that are not in mental health applications such as credibility support [75].

In general, only a few persuasive strategies were employed in the apps that I reviewed which might explain the high attrition rate.

### **3.5.2 Persuasive Strategies and Type of Mental Health Issues**

Most of the mental health apps that I reviewed targeted a combination of mental health issues which make it hard to know which persuasive strategies are more effective for a specific mental health issue. However, personalization, self-monitoring and reminder remain the most employed persuasive strategies in various mental health issues. Anxiety,

stress, depression and general mental health issues were the most issues the apps in this review target.

### **3.5.3 Apps Effectiveness and Persuasive Strategies Employed**

The effectiveness of the app was measured based in the app's rating. Interestingly, I found no relationship between the number of persuasive strategies and apps effectiveness as indicated by users' ratings. This is particularly an interesting result considering the recent discussion and open research question on whether persuasive systems employing a multiple persuasive strategy are more effective than those employing a single strategy [167]. My findings suggest that the number of strategies employed in apps design may not be related to the apps' effectiveness. According to Orji et al. [167], this is probably because employing a single appropriate strategy may be better than employing multiple inappropriate strategies or a combination of appropriate and inappropriate strategies that may have a cancellation effect. Hence, it is important that designers focus on selecting the appropriate persuasive strategies having both the target audience and the target behaviour in mind.

### **3.5.4 Design Recommendation**

Based on my findings, in this section, I offer some recommendations for designing mental health applications to improve users' adherence and engagement and hence apps' effectiveness. Moreover, some recommendations provided are from user app reviews, although the qualitative comments are not the focus of this work, I have integrated certain comments to support my recommendations. I refer to reviewer comments using [Rid], where R = reviewer and id = a unique number used in identifying each review (reviews from users are included verbatim throughout the article, including spelling and grammatical mistakes).

Designer should employ self-monitoring in the apps that target mental health issues to help users to track their personal data and see their improvements over time. Allowing people with mental health issues to track and visualize their personal data in various format, would provide opportunity for self-awareness and help users take control of their mental health

management. For example, “I love the app. It allows you to track emotions, experiences, discoveries, actions you took” [R29]. A major drawback is that most mental health app that employ self-monitoring use manual tracking which makes them tedious, time consuming, and users are likely to forget. To overcome this limitation, I suggest that designers employing self-monitoring should simplify the process and reduce the amount of work involved by automating behaviour monitoring process whenever possible [162]. Although certain behaviour data cannot be automatically tracked without users’ involvements due to technology limitation. Therefore, for such behaviours that cannot be automatically monitored, designers should incentivize users and reduce the perceived tediousness of the self-monitoring process using complementary persuasive strategies such as reminding users to log their behaviour, rewarding users for tracking their behaviours each day, and reducing the number of steps required to record behaviour” [162].

Provide adaptive functionalities that allow users to adapt some app features such as the font size, font color, background, layout, type and length of meditation, breathing, and other mental health improvement tasks to suit each user’s preferences and unique mental health needs. *For example, “The breathing exercises are great because I can set the type and time which I see as a great feature” [R487].* Personalization increases system relevance and usefulness [173], enhances system’s overall usability and ensure a personalized experience for each user. Moreover, adjusting app contents based on user’s personal data will increase the effectiveness of the mental health interventions. In addition, since many mental health applications targets more than one mental health issues, it is necessary that the apps' content be adapted based on the type of mental health issues that users might be experiencing. However, even people suffering from the same or similar mental health conditions may have unique needs that require individualized solutions, hence highlighting the need to personalize mental health apps to each individual.

Provide an adequate reminder to remind user to track their data or to perform their meditation, breathing, and other mental health-related task. *For example, “I like a short notification “How are you feeling?” from time to time” [R213].* Although reminders can help to increase adherence and reduce dropout rate, a lot of annoying reminders can lead to disengagement. Therefore, developers should be careful when designing the reminder



in mental health apps to avoid annoying people with frequent and unsolicited reminders. One way to achieve a balance between providing an effective reminder that will encourage users to adhere to the intervention and avoiding unnecessary reminders that will annoy user and make them disengage from the app is to tailor reminders to each individual. Individuals can be allowed to customize not only the frequency at which reminders are sent to them (how often), but also the type of reminder (pop up, text message, sounds etc.) and when it should be sent (time).

The mental health apps should provide a means for users to verify the reliability of their content and provide mental health information that are scientifically proven and endorsed by expert third parties. *For instance, “It works, and the science behind it is impressive” [R7].* This will increase app credibility hence motivating users with mental health issues to engage with the intervention [24]. Possessing the adequate technical skills to be able to develop an app is not enough for designing apps that will effectively improve or support mental health. Credibility strategies are particularly important in mental health applications considering the sensitivity of the subject matter. Users need to be assured of not only the effectiveness and reliability of the app contents, but also that their data will be protected (privacy).

Mental health apps could benefit from implementing rewards and praise. For example, *“the growing tree is a nice way to see my practice is growing” [R201].* Showing the growing tree as a kind of reward might motivate users to engage with the app. Moreover, providing users with mental health with motivational message when finishing the activities or task might encourage them continue using the app. Although designers may argue that improving mental health is an intrinsic reward of using their app hence no extra reward is required, however, it does not overwrite the need for extrinsic rewards such as badges, points, which has been shown to be effective at engaging users [176] . According to Orji et al. [235], performing health behaviours is often difficult due to lack of immediate tangible benefit, offering intermediate rewards such as points, badges, may help engage the users while the await the intrinsic reward.

Employ Reduction and Tunneling to simplify mental health apps and guide users through the step-by-step process required to achieve the desired mental health outcome. *For*

*example, “Users of the app are guided step by step in using every aspect to support their emotional health” [R73]. This will also reduce the tendency of stressing users out by allowing to figure things out themselves and hence reduce the overall dropout rate. Individuals experiencing mental health conditions are often advised to avoid stressful situations including complicated tasks that may stress them out and worsen their situation. Employ the Social Support strategies in mental health apps (eg, user forums) to provide users opportunity share their experience and support each other. Most people suffering from mental health issues often feel isolated or stigmatized, hence the need for social support. For example, “It’s a really good way to connect and feel connected to other people who have the same problem as you; even if you think you’re alone” [R73].*

### **3.6 Chapter Summary**

In this chapter, I deconstructed distinct persuasive strategies employed in 103 mental health applications using the Persuasive Systems Design (PSD) model and Behavior Change Techniques (BCTs). I and another researcher independently coded 103 apps description using the PSD model and BCTs. I further classified the persuasive strategies based on the type of mental health issues the apps aimed to address and how the strategies are implemented/operationalized in the mental health apps. The results show that self-monitoring, personalization and reminder are the most commonly employed persuasive strategies in mental health apps irrespective of the mental health issues. I also found that anxiety, stress, depression, and general mental health are the mental health issues the apps mostly focused on. Above all, I uncovered that there is no relationship between the number of persuasive strategies employed and apps’ effectiveness as measured using user ratings. I discuss various ways each persuasive strategy was implemented in mental health app to achieve the desired objective. Finally, I offered some design recommendations for mental health apps based on my findings.

In this chapter, I review 103 mental health apps available on the App Store and Google Play and identify the most commonly employed persuasive strategies in mental health apps and their implementations. However, there is a need for research to explore and understand end users' perceptions, needs, and concerns with respect to such technologies. In the next

chapter, I conduct a focus-group study to uncover the opinions, perceptions, preferences, and experiences of people who have experienced some form of mental health issues to inform the design of a next-generation mental health app.

## CHAPTER 4: USER PERCEPTION OF MENTAL HEALTH APPLICATIONS

*Chapter overview:* Chapter 3 highlights the persuasive strategies of 103 mental health applications available in the App Store and Google Play and their implementations. In this chapter, I present the results of the focus-group study <sup>3</sup> that was conducted to understand the opinions, perceptions, preferences, and experiences of people who have experienced some forms of mental health issues based on self-diagnosis to inform the design of a next-generation mental health app that would be substantially more engaging and effective than the currently available apps to improve mental health and well-being.

### 4.1 Motivation of this Work

Mobile health technology (mHealth) is considered a promising tool to help users engage in their health care. Specifically, the ubiquitous nature of smartphones and other handheld devices makes them ideal tools for delivering mental health interventions. The increasing number of mobile device users has created opportunities to develop mobile applications for delivering health interventions [120]. Moreover, mobile applications can assist people with mental health issues by incorporating self-monitoring, psychoeducation, self-management, and treatment options. These applications can be especially appealing because of their anonymity, ease of access, and ease of use [112]. Consequently, researchers are increasingly using mobile applications as tools for delivering health interventions. A key challenge, however, is how to design interventions that are effective and acceptable to people experiencing mental health issues. I believe that the best way to

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<sup>3</sup> Originally published in **Alqahtani, F., Winn, A., & Orji, R. (2021).** Co-designing a mobile app to improve mental health and well-being: Focus group study. *JMIR formative research*, 5(2), e18172.

design such apps is to employ the user-centered design (UCD) approach that engages intended users and involves them in the app’s design process.

## **4.2 The Objective of this Work**

The goal of this work is to explore the opinions, perceptions, preferences, experiences, and ideas of people who have experienced mental health issues based on self-diagnosis so that I can design a mental health app that would be engaging and effective at improving mental health and emotional well-being.

## **4.3 Methodology**

### **4.3.1 Study Design**

I conducted a focus group study with people who have experienced mental health issues based on self-diagnosis to (1) explore the ways people manage symptoms and overcome their issues; (2) understand their opinions, preferences, ideas, experiences, and needs in relation to 2 selected mental health apps; and (3) engage them in a co-design session.

#### **4.3.1.1 Participants**

I recruited participants by email (in both academic and non-academic environments) and social networks (Facebook and Twitter). I conducted 6 focus groups, with a total of 32 participants (age range of most of my participants [88%] was 18-34 years; 16 males and 16 females) who had experienced mental health issues based on self-diagnosis. Each group had 4 to 7 participants and lasted 60 to 75 min. A total of 20 participants had used general health apps, whereas only 5 participants had used a mental health app to manage their mental health issues. I had a relatively diverse population in terms of gender, age, education level, and the type of mental health issues (Table 4.1).

Table 4.1 Demographics of 32 participants.

Gender	Female 16 (50%), Male 16 (50%)
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Age	18-24:18 (56%), 25-34: 10 (31%), 35-44:2 (6%), 45-54 1 (3%), ≥55: 1(3%)
Level of education	High school or equivalent 12 (38%), College diploma 4 (13%), Bachelor's degree 9 (28%), Master's degree 6 (19%), Doctoral degree 1(3%)
Mental health concern	Stress 22 (69%), Anxiety 7 (22%), Depression 5 (16%), Low mood 3 (9%), Panic attack 2 (6%), Worry 1 (3%), Fear 1(3%)

#### 4.3.1.2 Procedure

I conducted single-sex focus groups as people may not feel comfortable talking about personal issues, such as mental health, in mixed-gender groups. I began the focus groups by asking questions to guide the group through topics related to the research topic while also taking a flexible approach and following unanticipated ideas that emerged during the discussion. The goal of the focus groups was to explore people's mental health issues, needs, and concerns about mental health mobile apps, including discussing users' perspectives on mental health mobile apps using 2 sample apps. The focus group session format was designed to unfold over 3 phases.

Phase 1: exploring the type of mental health issues that participants have experienced and how they have managed symptoms or overcome the issue

Phase 2: understanding participants' perspectives, preferences, opinions, concerns, and needs in relation to 2 selected mental health apps

Phase 3: engaging participants in a co-design workshop

The main goal of this structure was to use the first and second phase discussions to establish common ground by helping participants reflect and discuss different ways of managing their mental health issues and understanding their perceptions. These discussions were then used to spur a co-design session where each participant designed an app to help them overcome or control their mental health issues.

#### 4.3.1.2.1 Phase 1: exploring users' experiences with mental health issues

In this phase, I focused on exploring the type of mental health issues that users had experienced and how they dealt with these issues. I asked participants about their experiences with mental health issues and what they usually do to control or manage these issues. I also asked them if they had used a mobile app to help with their mental health issues.

#### 4.3.1.2.2 Phase 2: understanding participants' perspectives, opinions, preferences, concerns, and needs in relation to 2 selected mental health apps

I asked the participants to download and use two mental health apps—Happify and Self-Help Anxiety Management—2 days before the focus group session, giving them time to explore and have a sense of how the apps worked by using them before the focus group session. In addition, I gave a demo of the two apps in the focus group before our discussion of the apps. I chose these two apps for the following reasons: the Happify app is complex and comprehensive with a high number of behavior change strategies implemented, whereas the Self-Help Anxiety Management app is simple and employs fewer persuasive strategies based on previous work [10], and both apps were reviewed by mental health professionals and were published on the Anxiety and Depression Association of America's website [3]. In this phase, I demonstrated the Self-Help Anxiety Management app first because it was the simpler app and asked participants about their initial reaction to the app, the things they liked most about the app, what things they liked least about the app, and the things they did not like in the app. Following this, I demonstrated the second app (Happify), followed by the same questions asked about the first app. Finally, I asked them whether they felt that gender impacted the use of mental health apps.

#### 4.3.1.2.3 Phase 3: engaging participants in a co-design workshop

In this phase, I provided participants with paper and a pencil. I then asked them to pretend that they were the designers of mental health applications and invited them to sketch their ideas of their ideal mental health app in words or pictures. I asked them to think about what they would like and want to see in their own mental health application. After they finished, I asked each participant to share his/her design and, as a group, I dialogued about the user-generated designs, discussing what participants liked and disliked in each design.

### 4.3.2 Data Collection and Analysis

During each focus-group session, I gathered data by audio-recording the session with the participants' consent and through design artifacts (Sketches) to better understand 1) participants' personal ways of caring for their mental health issues, including general depression, stress, low mood, and anxiety; 2) their perceptions, opinions, needs, concerns, and ideas in relation to the selected mental health apps; and 3) how they reflected their needs, ideas, and perceptions in their own designs (Sketches).

All group sessions were audio-recorded and transcribed for coding. To analyze my data, I conducted a thematic analysis [36]. I chose thematic analysis because it allowed us to analyze a large data set in a systematic manner that uncovered patterns in the text while taking into account the context of what participants said to more accurately inform my interpretation of the data. I followed Braun and Clarke's six-phase framework for conducting a thematic analysis [36]: 1) becoming familiar with the data, 2) generating initial codes, 3) searching for themes, 4) defining themes, (5) iteratively reviewing themes, and 6) writing up the results.

Specifically, two researchers individually read and reread all transcripts (iteratively) to identify codes using open coding. Following this, the two researchers met in a series of meetings where the codes were expanded, developed, and modified and new codes emerged. For each phase of the study-group session format, I wrote each code on a separate sticky note and posted all generated codes on a large whiteboard to help with identifying the themes. On each sticky note, I wrote the number of times and in which focus group the theme was mentioned (see Figure 4.1). After many iterative reviews, where I identified which themes could be revised or combined, the researchers identified a clear theme (see Figure 4,2). Next, to further refine the themes, the authors presented and discussed the themes with a group of 12 researchers in the HCI Lab who had fairly good knowledge of the research area. Based on their feedback and discussions, I generated a final iteration of the themes. I presented the results of each phase in the sessions and provided quotes as specific examples from each theme within the results. Table 4.2 shows the frequency of



occurrence of each theme that emerged in each phase. I identify participants by number (e.g., P1, P2, ...) and which group each participant was associated with (e.g., G1, G2, ...).



Figure 4.1 Codes generated from each phase (1,2, and 3) in order from left to right



Figure 4.2 Themes generated from each phase (1,2, and 3) in order from left to right

Table 4.2 Coding frame detailing the frequency of occurrence of the themes within the data

<b>Themes (frequency)</b>		
<b>Phase 1</b>	<b>Phase 2</b>	<b>Phase 3</b>
Doing something to distract themselves (22)	The need to enhance the app design (71)	General design characteristics (27)
Relaxation exercises and approaches (20)	Tracking of personal data (18)	Self-tracking of personal data (20)
Social interaction (14)	In-app social community (16)	Providing feedback for the users (20)

<b>Themes (frequency)</b>		
Looking for an external source of support to solve the problem (11)	Motivational content (14)	Providing live support (18)
Doing something to motivate themselves (10)	Personalization (11)	Personalizing the app's style and functions (18)
Helpful thinking (7)	Providing Feedback from the app (10)	In-app social community (17)
Doing physical exercise (7)	The need for enhanced privacy and security features (8)	Motivational content (14)
Managing Their Time (6)	The need for relaxation approaches (7)	Providing relaxation exercises (10)
Religious practices (3)	Providing professional support (4)	Including a Google map function in the app (7)
Isolating themselves (1)	Including games for entertainment (4)	Including simple games for entertainment (7)
	Including Google map function (2)	Providing Relaxation audio (6)
	Participants' perceptions regarding gender differences when using mental health apps	Personal assistance in the app to help users (5)
		Goal setting (3)

Themes (frequency)		
		Privacy (2)

## 4.4 Results

### 4.4.1 Users' Experiences with Mental Health Issues

All participants (100%) reported experiencing stress, anxiety, depression, panic attacks and/or low moods at some point in their lives. They reported a variety of factors impacting their mental health. Stress and anxiety caused by *studying at university* were the most common issues discussed and were reported by half of the participants (53%). Moreover, *being a mother* (both during pregnancy and in raising children), *money issues*, *losing a job*, *losing friends*, *childhood abuse*, *family or community issues*, and *having a large number of commitments* were mentioned as factors that contributed to them experiencing mental health issues.

Participants shared a variety of ways they had used and were using to deal with and manage their mental health issues. I identified ten core themes related to the approaches used by the participants: *doing something to distract themselves*, *using relaxation exercises and methods*, *social interactions*, *looking for an external source of support (i.e., someone/information) to solve the problem*, *doing something to motivate themselves*, *helpful thinking*, *physical exercises*, *managing their time*, *religious practice*, and *isolating themselves*. Responses from participants in support of each theme are discussed in detail below.

#### 4.4.1.1 Doing Something to Distract Themselves

The participants used many strategies to distract themselves from unpleasant feelings. For instance, participants who were usually stressed, anxious, or depressed wanted to “run away” and desperately sought a way out. As a result, they spent time shopping, on social media, sleeping, focusing on work or study, or changing their environment, for instance, by physically going to a new location. All these they did as coping strategies as illustrated

in the sample comments below: (Comments from participants are included verbatim throughout the chapter. G1P1: *“Every time I feel down or something, I would go to school just to run away and do something like this.”* G5P3: *“I sleep when I feel down or stress.”* G3P5: *“If I feel stress, I will go out to change the environment.”*

In addition, when participants experienced mental health issues, they tried to entertain themselves by playing video games or mobile app games to distract themselves from their current situation as demonstrated in some sample comments below. G2P1: *“I spend a lot of time on video games.”* G5P2: *“I used to play a game when I am stressed to distract myself.”*

Some people mentioned that eating to deal with their emotions was a strategy that helped them to forget their stress. G5P2: *“If I am depressed... I eat something that I like. I do anything that makes me feel better.”* G2P1: *“When I am stressed, I eat a lot even if I feel I am full.”*

#### **4.4.1.2 Relaxation Exercises and Approaches**

Participants mentioned that doing relaxation practices, such as breathing or meditation, via a mobile app, YouTube, or Fitbit assisted them with reducing stress, relieving symptoms of depression, and boosting feelings of joy and well-being. G1P2: *“Trying breathing exercise to mitigate the stress.”* G6P6: *“I start to use some application that has some meditation, and it works.”*

Furthermore, doing CBT over a long period of time helped participants handle panic attacks. G6P3: *“I did CBT for long time ... so when attack comes, I know how to handle it.”*

Moreover, they mentioned that practising gratitude before bedtime for about a month assisted them in being more positive and reducing negative thoughts. G6P4: *“Before I sleep, I write three things that I am grateful for. For example, I am grateful for having a family ... and this change me too much. I became more positive I can control my stress, fear.”*

With respect to relaxation exercises employed by my participants, they highlighted that listening to natural sounds and music helped them to reduce their stress. G1P2: *“I have tried one app that has natural sounds such as rain which help to sleep better.”* G6P5: *“I usually listen to music. It helps a lot.”*

They also reported that strolling or sitting outside in a natural environment were other ways in which they could reduce their stress and anxiety. G3P5: *“If I feel depressed or sad ... sometimes I like to walk next to the waterfront or in a garden.”*

Moreover, making herbal tea to reduce worry and stress was also mentioned by a participant. G1P3: *“Sometimes I made herbal tea to relax and overcome the stress.”*

#### **4.4.1.3 Social Interaction**

Participants mentioned that talking with their mother, hearing their mother’s voice, and knowing their mother was praying for them were some of the most relieving things for them when they experienced mental health issues. G1P2: *“I just call my mom and I want to hear her voice and chatting, and she prays for me that is the most relieving thing.”* G1P12 *“Because maintaining my mental health leads to my being appreciated by the people I know.”*

Furthermore, spending time with friends and nurturing their partners were also mentioned as ways of reducing depression, stress, and anxiety. G1P1: *“I call friend and talk about it.”* G1P4: *“In order to have a healthy life with your partner, you need to take time with him.”*

Moreover, having a person that the participant was comfortable with and that they can talk to about a troubling issue brought participants some relief. G5P4: *“Talk to a comfortable person, that helps me so much.”*

#### **4.4.1.4 Looking For an External Source of Support to Solve the Problem**

Looking for information or people that could help to solve their mental health issues and help them feel some relief was another approach used by participants when they felt depressed, stressed, or anxious. Some participants joined a wellness group to share their

issues and find someone who could provide them with suggestions or solutions for their issues. G6P4: *“I attend one session in the health and wellness center, and they teach us how to manage our stress and fear and how change our mood.”* G3P3: *“Now I join a wellness group.”*

Some participants went to see a doctor, psychologist, or counsellor to find a solution for their depression or sleeping difficulties. Some of them used medication to help with their symptoms. G3P3: *“I went to my doctor, and he said to me we need to talk we need to do something about this and I started some medications which worked for me.”*

Additionally, people searched for a solution to their mental health issues using Google. However, they stated that this approach was not always an accurate source of health information. G6P3: *“The hypochondriac is the most stuff, so I am using Google.”*

#### **4.4.1.5 Doing Something to Motivate Themselves**

In this section, participants mentioned internal and external motivations they accessed when they felt down, stressed, or in the midst of a panic attack. One of the approaches they used was self-talk which is an internal form of motivation people practice by repeating motivational sentences or affirmations to support them in stopping negative thoughts. G6P7: *“Regarding to panic attack, I just try to tell myself this is not real to get myself feel good again.”*

Participants reported following inspirational people on the internet and rewarding themselves after hard work as examples of external motivations they used to encourage themselves to be more positive and reduce their mental health symptoms. G6P4: *“I also follow some inspirational people in the internet to motivate me.”*

#### **4.4.1.6 Helpful Thinking**

Some participants tended to think of the ‘bigger picture’ surrounding their issues to see the benefit of the issue; this strategy helped them to reduce their stress. G4P1: *“I think about the overall picture. I am talking about my case for overcoming my stress... helps me so much.”*

Additionally, some overcame their fear by facing the things that generated that feeling. G4P2: *“If I am afraid from something, I do it. I found it very effective just facing your fear.”*

Another strategy to avoid feeling depressed was to force themselves to do the thing that generated the depressed mood. G2P2: *“So when I do poorly in school I can go to the depressive episode where I stopped going to class, I just don't feel good. The ways that I have had to deal with it ... and force myself to wake up and go to the class.”*

#### **4.4.1.7 Doing Physical Exercise**

Participants stated that being physically active improved their mental well-being by reducing anxiety, depression, stress, and negative mood. Hence, they overcame their depressive feelings and anxiety by going to the gym, walking, or dancing. Some played physical games, such as soccer and billiards, which helped to release their negative feelings. G3P2: *“I do something I like, such as playing billiard, and soccer.”* G1P3: *“Dancing at home makes me feel better.”*

#### **4.4.1.8 Managing Their Time**

Some participants highlighted that identifying priorities and being more rigid with their schedule helped them to reduce stress and depression. G5P5: *“I just organize my time at least what I should do for each day to reduce my stress.”* G2P2: *“I try to be more rigid with my schedule.”*

They also mentioned that creating time to do something enjoyable and removing anything that contributed to their stress helped them in dealing with their mental health issues. G1P4: *“Stress is only created when you keep things inside you...so I started creating my own time I do what I want to do. I need my me time.”*

#### **4.4.1.9 Religious Practice**

Some people stated that reading religious books and praying reduced their symptoms of depression and anxiety, as well as enabled them to cope with stress better. G3P4: *“I seek something religious. Do the things I believe in, reading the religious book.”*

#### 4.4.1.10 Isolating Themselves

One person stated that when he experienced mental health issues such as feeling depressed, he preferred to withdraw and isolate himself. G5P4: *“I preferred to be isolated.”*

### 4.4.2 Understanding Participants’ Perspectives, Opinions, and Preferences in Relation to Two Selected Mental Health Apps

I identified several themes related to participants’ perceptions, needs, and preferences in relation to selected mental health apps. I discuss each of these themes along with related subthemes below.

#### 4.4.2.1 The Need to Enhance the App Design

**Usability:** Usability is an essential factor in users’ experience of mental health applications.

**Easy to use:** Most participants highlighted simplicity and ease of use as important in the mental health apps that they really like to use regularly. G5P2: *“The home page is a very complex design. It would be better to design like icons to be easy to use.”*

**Easy to navigate:** Participants liked to be able to find relevant or required information or app components more directly and quickly. G2P5: *“I feel there are lots of things going on that it takes many steps to go there.”*

**Organized and simple home screen:** Participants liked apps that were organized and had fewer details on the home screen. They preferred that app information be presented in a non-overwhelming way. G1P3: *“I liked the layout organize of the app.”*

**Tutorial:** Participants expressed a preference for apps with simple instructions on how to use the app. G2P3: *“If the app has a little tiny pop-up for each activates to give you brief overview, how it works so it would not be confusing.”*

**App Content:** Participants liked having a variety of activities in the app and felt that this activated their curiosity. They liked apps that have regular content updates, and the



information content in the app had to be from trusted sources. Moreover, some participants liked content that shifted their attention away from their current issues

G1P3: *“The information they provide looks more trustworthy than the other. There are some links I can check them out.”*

G5P5: *“This app does not have anything that let you remember your stress or depression just play games and read an article which is good.”*

G4P2: *“The app should not show stress or depression as the illness it should show as something normal that we all face in our life.”*

**Basic design:** Participants highlighted the importance of the app having a clear purpose.

G4P2: *“Users need to understand the main purpose of the app easily.”*

They also mentioned that the app name should be both simple and not include/mention or be related to any mental health issue because they do not want others to know that they are using a mental health app. G3P5: *“I like that it is called happify. You are clicking to happify not clicking to anxiety. Even the color is bright and happy.”*

Participants preferred the colour scheme of the app to be bright and calm. They also liked apps that support different languages.

G5P3: *“It need to include other languages not only English.”*

G2P2: *“I like the app color. It is calm.”*

#### **4.4.2.2 Tracking Of Personal Data**

Participants reported two types of tracking: self-tracking, and auto-tracking. For self-tracking, participants wanted to make their own notes and track their successful personal solutions. The app should be able to support that. G3P1: *“I like taking note so I can know if there is improvement or not.”* G2P1: *“I really like the anxiety tracker which shows your progress and kind it gives yourself hope that you will get better, and you can report in the things that make you up and dawn.”*

For auto-tracking, participants wanted their emotions to be tracked based on the auto-tracking data of their sleep, heart-rate, and phone use.

G2P1: *“What if you have something that can track your sleeping time and maybe heart rate and know your feeling based on that.”* G1P2: *“I do not think users can rate his/her level of anxiety. I prefer sensors to give the rate of my stress like hear-rate.”*

#### **4.4.2.3 Social Community in the App**

Participants highlighted their desire to have a social community within the mental health app to interact socially with other users who have the same issues. This would enable them to share issues, give each other advice, and relate to other people’s experiences. They also liked anonymous communication in the social community and the ability to post a picture. Including a video call option in the social community and having a professional monitor in the group was also suggested.

G3P5: *“I like the community in the app, so you have someone to share with.”* G4P1: *“Social community will be the main thing I will go for it.”* G5P3: *“I like you can post the picture to the group.”*

#### **4.4.2.4 Motivational Content**

Participants mentioned two types of motivation: motivation to encourage participants to be positive and motivation to encourage participants to use the app. Participants emphasized that the app should provide them with inspiring stories and positive news and quotes, pictures, and articles that improve their mental well-being and motivate them to be more positive.

G5P: *“I like the positive news. It is good to have it in the apps.”* G6P1: *“If there is an inspiration quote, it will be good.”*

Some reported that the app should allow them to gain rewards after each task they have done and compare their points with other users in the app, which would motivate them to keep using the app. G5P1: *“I like the points and specially if I can make it competition with other users so I can compare my points with my friends which let me practice more.”*

#### 4.4.2.5 Personalization

The ability to personalize the interface, for example, by customizing reminders, background, colour, and music, was attractive to participants. Some also wanted to be able to add personal strategies in their profile so the app could make personalized suggestions when they experience a crisis. In addition, some participants would like the app to administer an assessment before using the app to personalize the content based on the users' answers. However, this assessment must be short. They would also like the app to greet them personally, by their name.

G1P2: *"I like the level and the assessment in the beginning, it can be used to make the app personalized."* G4P5: *"Adding personalization in your app like Hi (name), how you are feeling today?"*

#### 4.4.2.6 Providing Feedback from the App

Feedback from the app was divided into two types: notifications and suggestions.

**Notifications:** Participants highlighted that the app should send them periodic notifications to check on them, either randomly or at user-defined times. G3P3: *"There is no notification or reminder to remind me to use the app so I will forget it."* They also highlighted the need for the app to notify them about their feelings based on their tracked personal data. G2P2: *"The app could do more work in the background, send a notification and check during the day how's your day today."*

**Suggestions:** Participants wanted the app to provide helpful suggestions based on auto-sensed data related to their current circumstances. These suggestions could be positive articles, health advice, strategies to overcome the mental health issue, personal strategies that were previously recorded to make users feel better, or advice for the user to contact a doctor. G1P1: *"...for example when you set up your account with the app, they will ask questions, what makes you happy? What is your hope? So a month later if I feel down, they will suggest that I make a herbal tea for example."* G3P1: *"There should be a suggestion to contact a doctor."*

#### **4.4.2.7 The Need for Enhanced Privacy and Security Features**

Participants expressed a preference for the option for an individual mode, as opposed to an online community mode, where they can make personal notes and express their feelings within the app privately.

G5P4: *“I will use the private mode first then after a while when I trust the app, I can change it to be community mode.”* G3P4: *“Asking permission to access my photo, contact is good.”*

They also preferred the option to use an app without creating an account. G3P5: *“Creating an account is something annoying for me. I do not like to create an account.”*

Participants also emphasized the importance of the lock feature in mental health apps to protect their collected data and information. G1P3: *“There is no locking feature in the app and that increased my concern regarding privacy.”*

#### **4.4.2.8 The Need for Relaxation Approaches**

Participants reported the importance of practicing relaxation approaches to reduce unpleasant feelings and feel better. Self-talk, and breathing exercises were the strategies that users wanted to have in their mental health apps.

G1P2: *“I like the breathing exercises in the app.”* G6P4: *“The app should allow users to speak to themselves.”*

#### **4.4.2.9 Providing Professional Support**

Participants suggested that the app should provide access to mental health professionals' support by either providing the contact details of doctors, coaches, and a suicide crisis hotline or by providing live therapists who can be accessed to respond to their concerns.

G3P2: *“If there is icon that you can contact doctor, clinic, it will be good.”*

G2P3: *“There should be a hotline for suicide.”*

#### **4.4.2.10 Including Games for Entertainment**

Participants reported that apps need to include fun games as a way to reduce stress.

G5P5: *“The app should have entertainment such as game not only record your notes and mood.”*. G1P3: *“I like the game idea it is a kind of entertainment.”*

#### **4.4.2.11 Including Google Map Functionality in the App**

It was suggested that mental health apps should have a Google map functionality that shows centers and communities for mental health support that are geographically near the user. So, when users feel down, stressed, or depressed and are using the app, they can easily find a physical community for support.

G5P4: *“If there is icon that show the center or society that help people for example the app has Google map and show the mental health center and society that nearby users.”*

#### **4.4.2.12 Participants’ Perceptions Regarding Gender Differences in Using Mental Health Apps**

Some participants believed that men would be less likely to use mental health apps because women tend to look for ways to express their feelings while men tend to hide their feelings and pretend that nothing affects them. However, other participants felt that mobile applications could motivate and help men to express their emotions. Others felt that differences in using mental health applications are less gender-related and more likely dependant on the personality type of the users.

G3P3: *“I think women use mental health app more because they are more emotional, and the man can keep his emotion and pretend nothing affects him.”* G2P1: *“I think all men and women use mental health app but it depends on the personality. There may be some women do not like to use an app and as well as men, so it depends.”*

### 4.4.3 Co-design Workshop

The co-design workshop produced 32 participant design sketches and an extensive set of app design components, including user-preferred features, functionalities, and characteristics that mental health app users would like to use. The researchers identified a total of 13 major themes from the co-design workshop. I discuss these themes below.

#### 4.4.3.1 General Design Characteristics

Simplicity and ease of use were mentioned by participants when they explained their design. They highlighted that this would allow them to learn the app quickly. G2P2: *“I kept mine as simple as possible. I was thinking of a person who does not like to be on the phone or just needs the basics.”*

Additionally, they reported that mental health apps should include a tutorial or instructions for how to use the app. G5P3: *“The important thing for me is to show the users how to use the app.”*

Participants emphasized that mental health apps could provide 1) credible information in a way that is not overwhelming, 2) a variety of activities, and 3) crisis information support. G3P3: *“Any information should be from a qualified person, not anybody can post the information.”* G1P3 *“I would like to have a variety of activities such as yoga, breathing.”* G4P4: *“It provides ... emergency and instruction of what users should do.”*

Participants highlighted that mental health apps must have a simple name. Others suggested that the app’s name must not mention any mental health issues within it. G4P3: *“I suggested to name the app ‘solve your problem’ for example.”*

Moreover, it was recommended that the app should show the user’s achievements, what they like, and what they dislike in their profile. G2P2 stated that *“it has a profile of what you like and dislike and activities that make you happy and people that make you happy, things like that.”*

Some users suggested creating an account within the app to store their information, whereas others disagreed with this idea. Participants found a point of agreement with the

idea of making the account optional, and the app could provide more activities and content if the user chose to create an account and formally log in. G4P1: *“The app shows the analysis locally that user is using the specific relaxation activities, then it suggests for user that If you log in, you will be able to access more relaxation activities.”*

Participants would like to have favourites lists, enabling them to save their favourite videos and activities on the app so they can find them quickly later. G4P3: *“You can like the video, article and watch them again.”*

#### **4.4.3.2 Tracking Of Personal Data**

The tracking feature emerged in all six co-design sessions. 63% of participants highlighted self-monitoring as important feature in the app. There were various ways in which tracking was visualized by the participants in the co-design workshop. Specific ideas about how to design the tracker varied, with some participants indicating that they would like to have an auto-tracker to track their sleep time, heart-rate, time spent on the phone, and in-app achievements. Moreover, some people suggested that the app could auto-track users' emotions based on their heart-rate and breathing. Others suggested that the app should provide the ability to track their mood using a set of smiley faces, emotion words, or labeling one's emotions in detail to know the factors that could contribute to mental health issues (See Figure 4.3). G3P1: *“The app asks users what they feel and track other problems that may lead to depression such as obesity, social problem.”* G4P4: *“If the app can know your emotions through heart-rate and breathing, it would be great.”*

The app could also track users' alcohol consumption rates. G4P6: *“The app can track your drink and money to see how you are coping over time.”*

Others did not like this idea of self-tracking due to a high probability of error and consistent data input and preferred the app to predict their emotions based on the auto-tracking of their heart-rate. G5P2: *“It could be auto-tracking for blood pressure, heart-rate and knowing the emotions and providing recommendation based on users feelings.”*

Others suggested that the app should provide the ability to take note of emotions in detail to improve self-awareness. G5P1: “*You can track your feeling and write what make you feel down.*”

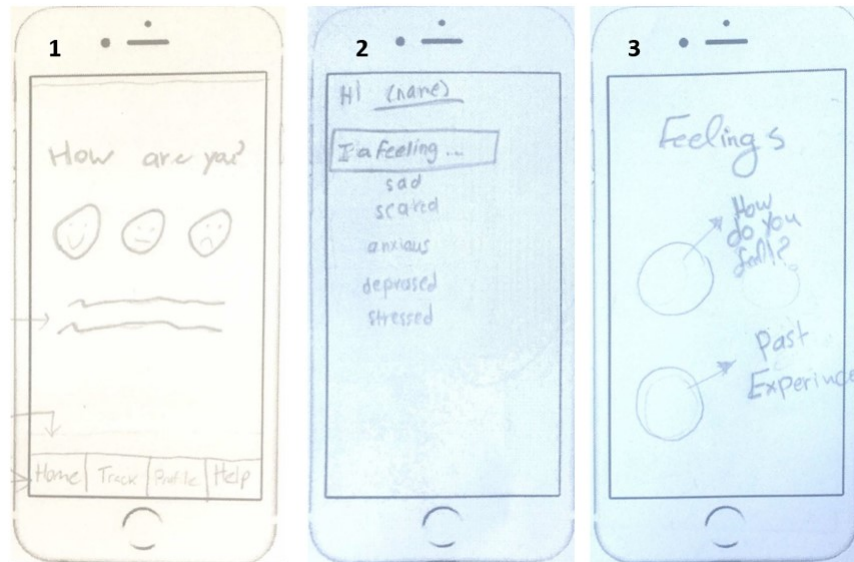


Figure 4.3 Three implementation ideas of a tracking feature were generated by participants: 1) simple tracker using a set of smiley faces, 2) using a set of emotion words, and 3) labeling one’s emotions in details

#### 4.4.3.3 Providing Feedback for the Users

I divided the app feedback into three types: notifications, suggestions, and reporting.

**Notifications:** Participants provided a variety of ideas for notifications. Participants wanted the app to remind them of positive things in general and good things happening in their lives as a way of redirecting their attention away from the negatives. G4P3: “*If you feel stress, your app reminds you of the good thing happening to you which can help you to relax.*” G6P7: “*The last thing is reminder to tell me a nice thing, everyone wants to feel good.*”

They would like the app to remind them to track their mood and activities. They would also like the app to check in on them to see if they need help, either through auto-track sensing or at random times. G4P2: “*I like the notifications because the apps that do not have a notification, are forgotten.*” G6P5: “*App can check me out at random time.*”



Participants would like to be notified if they have made progress towards overcoming their mental health issues by showing motivational messages. For example, G1P2: “*If the app sees you have done good progress toward the anxiety, it says ‘Wow, well done!’.*”

**Suggestions:** Participants would like the apps to provide suggestions on what to do based on their feelings. The suggestions could be built into the app, things such as reading positive articles, health advice, or news, or could be things users liked or which they entered previously into the app as things that worked for them (see Figure 4.4). G2P2: “*The app can track sleep or mood and immediately diagnosis and provide you with some suggestions on what you can do to feel better based on the data the app has about you.*”

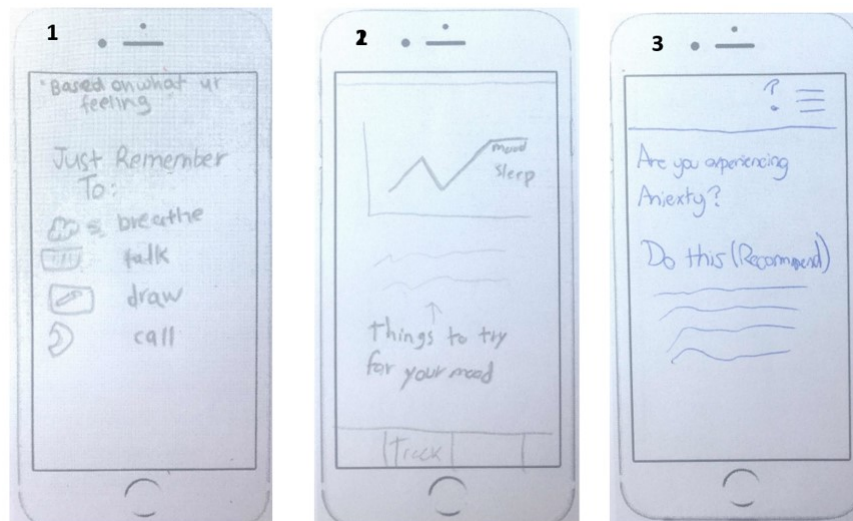


Figure 4.4 Three implementation ideas of a suggestion feature: 1) suggesting activities based on the moods entered, 2) providing suggestions to improve one’s mood based on collected data, and 3) providing general suggestions

**Reporting:** Participants highlighted that they would like the apps to provide a summary report of their data and/or progress which could be shared with their therapist. G6P6: “*The app shows a summary of the results.*” G2P1: “*The therapist keeps up to date and see how you are progressing or your behaviours.*”

Moreover, some participants expressed that they would like it if their therapist could access their data if they were given permission. G3P3: “*Therapist can access my data if I allow*

*it because I try to take note for each thing, having everything in the app will make it easy to show my doctor.”*

#### 4.4.3.4 Providing Live Support

Participants highly valued live support, either as personal or professional support. 56% of participants included live support in their ideal design. Figure 4.5 presents three implementation ideas of a live support feature that were generated by participants.

Personal live support allows users to provide contact details for friends and family to contact for support when necessary. It also allows for a way to contact a stranger through the app. G2P2: *“The app includes help information: call for help first option, search for a therapist is the second option, call a friend.”* G6P7: *“The app allows users to call a friend or to speak to someone who use the app even a stranger that can help.”*

Professional live support allows users to contact a doctor or therapist in their area. It also provides live therapists and coaches who can respond to their concerns. Participants would be willing to pay for sessions with a live therapist when necessary. G5P1: *“The last icon is about contact the therapist through online and it could have fees.”*

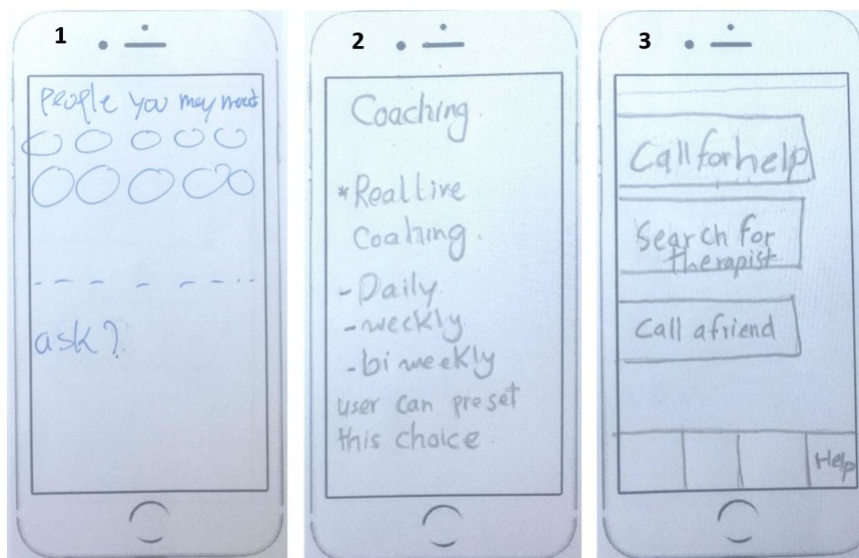


Figure 4.5 Three implementation ideas of a live support feature: 1) including therapists that users can contact and the ability to text them, 2) the ability to set up meetings with a live coach, and 3) the ability to call for help, contact a friend, or search for a therapist

#### 4.4.3.5 Personalizing the App's Style and Functions

The ability to personalize the app's style and function was attractive to 56% of participants. Figure 4.6 shows three implementation ideas of a personalization feature that were generated by participants. For example, they would like to customize reminders, background, colour, and music and create their own personal in-app strategies.

Participants would like to have an initial brief questionnaire that could be used to personalize their app experience based on the user's responses to the questions. For example, G1P1 stated that *"The app can have a brief questionnaire to get information to personalize the app."*

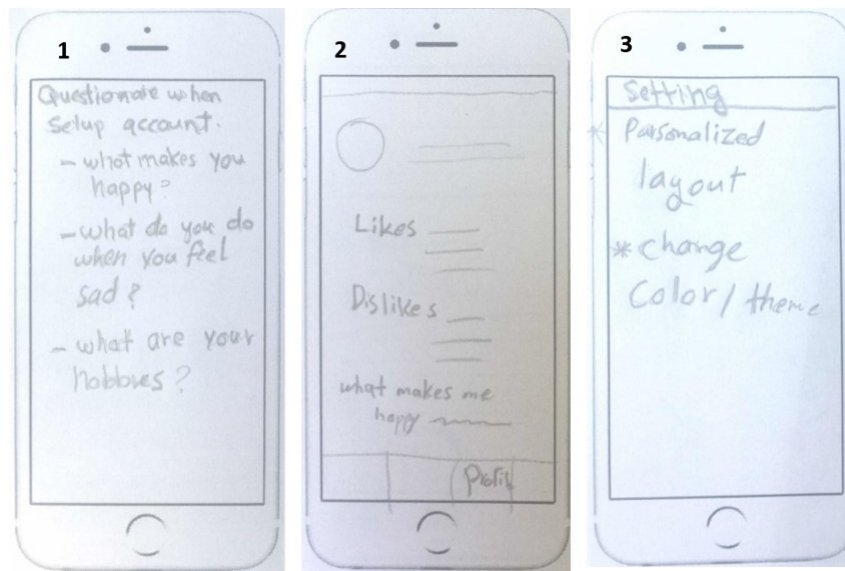


Figure 4.6 Three implementation ideas of a personalization feature: 1) asking a set of questions when setting up the app, 2) including a profile with users' likes, dislikes, and what make users happy, and 3) customizing the layout and theme of the app

Participants also highlighted the need for the app to provide them with solutions based on selected feelings or issues. For example, G4P2: *"The apps provide you with buttons with different issues, you can click on which one that you need help with, and it can direct you where you can find different solutions to the issue."*

Some participants said that it would be nice if the app could greet the user by name. G4P4: *"App can say hey with users name."*

Some participants would like the app to provide music and/or religious phrases based on what the users are currently feeling. G6P5: *“There could be different options for different religions, so I can choose based on my religion and pop-up phrase to inspire me based on my feeling.”*

#### **4.4.3.6 Social Community Feature**

Participants reported a desire to include a social community within mental health apps so that they could interact with other users who have the same issues, share their problems, and give each other advice.

The suggested design implementations for the social community were as follows:

The social community could have different groups created based on mental health or life issues. Users are able to follow any one of these groups by searching for issues they are facing or by answering an assessment questionnaire that directs users to the right group. Moreover, users could create a group for a specific issue and add people to it.

G2P4: *“In chatting can have different groups and different topics or I can create a group for depression in the school and anyone is interested can get in.”* G5P3: *“The app asks you questions such as what is your issue? and based on this assessment, it takes you to the group which has the same issues, then you can share your issues and do activates together.”*

The social community could have one-on-one chatting to talk to a person who has the same issue. The idea is that users can send a request and, if the request is accepted, they can chat together.

The social community could also offer voice calling, but it should be anonymous. It could also allow users to reply to a comment and upload pictures in the chat room. Figure 4.7 present three implementation ideas of social community feature.

G5P2: *“If user finds a person who has the same issue, he makes a match, if the person accepted, then they can do a voice call but it should be anonymous.”*

G4P4: “Enter your issues and the app shows you the people who has the same issues and their solutions.”

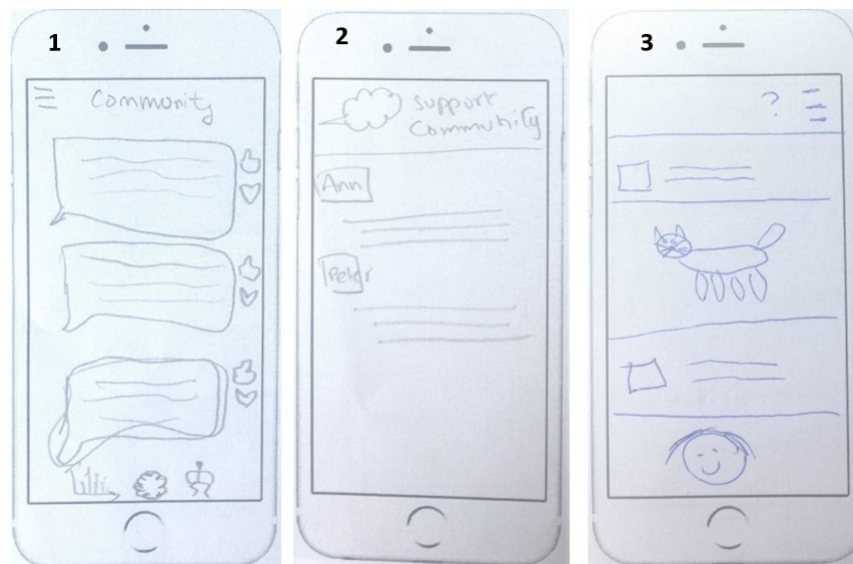


Figure 4.7 Three implementation ideas of a social support feature were generated by participants: 1) ability to reply to a comment, 2) ability to chat privately, and 3) ability to upload pictures in the chat room

#### 4.4.3.7 Motivational Content

Participants expressed a desire for positive motivational quotes or statements that are updated regularly. They would also like positive news available in different formats (such as text, audio, and video) and religious inspirational quotes in the apps to make them feel better. They also reported that the app giving them rewards after any accomplishment would motivate them to keep using the app.

G2P4: “The introduction page has simple motivation statements such as you are the best, be confident. It should be updated every 6 hours or make it daily.” G2P1: “Positive news is a good idea to have in the app which helps, and it can be in different format. Reading for people who like to read, video for people who like to watch and audio for people who like to listen.”

#### **4.4.3.8 Providing Relaxation Exercises**

Participants reported that the app could contain approaches for symptom relief, such as breathing exercises, yoga, recording thoughts, a forgiveness feature, and a regret feature. However, some people disagreed about the usefulness of a regret feature, as this could force them to remember unpleasant and depressive experiences, and this would not make them feel better.

G6P7: *“I want to record my thoughts. Sometimes when you have anxiety, you need someone to talk to, so recording something make you feel like you have spoken to someone.”* G6P4: *“I would like to add forgive feature to forgive people who hurt us, and we can do it monthly.”*

#### **4.4.3.9 Including a Google Map Function to Find Clinics Near Users**

Participants emphasized the idea of having Google map functionality that shows available therapists and communities for mental health support near the users. Additionally, participants wanted a map that shows organizations in need so they could volunteer and improve their feelings through helping others.

G2P4: *“It can have something like Google map to show the therapists that are near to me. It can pop up and users can select and contact.”* G6P3: *“If the app tells me to help this charity or community by showing them in the Google map.”*

#### **4.4.3.10 Including Simple Games**

Participants reported that the content of the app should be fun and interactive; thus, they included games in their design.

G1P2: *“There are four icons in home page as main categories including an icon for a game.”*

#### **4.4.3.11 Providing Relaxation Audio**

Participants highly valued the idea of having relaxation audio such as music, natural sounds, and worship and religious audio clips.

G6P7: *“The first thing I want is sound or music just to help me calm down.”* G6P5: *“For me personally, I like to hear worship sounds.”*

#### **4.4.3.12 Providing Personal Assistance in the App to Help Users**

Some participants reported that using advanced Artificial Intelligence (AI) technologies in mental health apps could help to improve their mental health issues by providing individualized emotional support, assessment, and advice based on their recorded data.

G4P6: *“You can click on and talk to your phone and tell it that something happened or that you feel bad. This could be simple or complex information and the app can understand you and give you a quick solution on what to do or suggest that you talk to your friend.”*

G6P5: *“Having a voice in the app talk to me and ask question. It is kind of robotic.”*

G5P4: *“It could be AI that responds to me and if the situation is serious it could tell me to contact a therapist.”*

#### **4.4.3.13 Goal Setting Feature**

Participants would like to set up health-related goals. The app could show them how many days they have left to complete their goal, which can motivate them to finish their task and reduce their stress.

G2P3: *“Goal setting shows how many days left to achieving the goal”.*

#### **4.4.3.14 Privacy Feature**

Participants highly valued when the app asks permission to access the personal data on their phone. Some would like to have a clear privacy policy that shows how their data will be protected.

G1P1 stated that *“There should be privacy agreement that there is no sharing of users information.”*



## 4.5 Discussion

This study aimed to explore the perspectives, preferences, opinions, and needs of those who have experienced mental health issues such as stress, general depression, anxiety, panic attacks, and low mood. Given the well-documented difficulties engaging people in promoting mental health, such perceptions are likely to be pivotal to developing a successful application for mental health interventions.

My results highlight that people who have experienced mental health issues are using existing strategies for dealing with mental health issues in their lives, and these strategies should be leveraged in designing a mental health app. Participants' ideas were organized into 14 over-arching themes showing what they want in a mental health app. Most of the desired characteristics, features and design implementations emerged in all six of the group sessions.

Regarding app design, participants emphasized that the app being simple, easy to use, and easy to navigate are essential characteristics for mental health apps. These characteristics were unsurprising and consistent with previous studies [13].

Moreover, allowing users to customize the app to suit their individual needs and preferences is an excellent way to improve user satisfaction, engage them, and, hence, reduce the currently high attrition rates associated with mental health apps [195],[21]. Moreover, it has been found in other health domains that personalized health interventions are more effective than those employing a one-size-fits-all approach [170],[167] and, in depressive and anxiety disorders, this is even more important [40], [205]. Therefore, it is not surprising that the participants of this study, who have experienced mental health issues, would like to personalize mental health apps to suit their needs so that they can benefit from individualized solutions.

Participants with mental health issues are usually looking for someone to help them solve their issues without judging or stereotyping them. Therefore, including a social community and access to live support in the app reflects this approach to dealing with their issues in real life as highlighted by the participants. This finding is similar to Alqahtani et al. [13] who found that including social support and emergency contacts in a mental health app



were appreciated by users. Therefore, sharing issues, advice, and one's solutions with people who have the same issue and the ability to contact professional support, family, or even friends are important for people who have experienced mental health issues. Unsurprisingly, because of the stigma associated with mental health issues, few participants suggested that contacting and talking to a stranger who has no possibility of knowing them is preferred and it would help to reduce their issues.

While participants reported a need for tracking features in mental health apps, their ideas were varied. Some participants would like their emotions to be predicted based on the app auto-tracking their vital signs, such as heart rate, blood pressure, and breathing, or based on auto-tracking their phone use since they do not trust their ability to self-track. In contrast, others suggested that the app could have self-tracking to enable users to track their positive emotions, successful personal solutions, and personal notes, all of which can improve their awareness. It is worth mentioning that self-tracking is the most frequently implemented persuasive strategy in available mental health apps [10].

The feedback theme is a combination of three features: notifications, suggestions, and reports. Notifications and reminders are highlighted as very important features to remind users to use the app. Apps without notifications or reminders will easily be forgotten. However, this feature should be customizable so that users can make it random or set up the frequency of reminders; they should also be able to disable it if they do not want reminders. Receiving suggestions based on a current feeling or progress toward the user's goal is a valuable feature to help users manage their symptoms and motivate them to keep using the app. Moreover, the ability to share a summary of the report with their health provider will save them time and help them facilitate an accurate diagnosis.

Participants stated that they often like to motivate themselves by repeating a motivational sentence, following inspirational people on the internet, or stopping negative thoughts. Therefore, including motivational content such as positive stories, news, and inspirational quotes in mental health applications will improve users' mental well-being. Moreover, they stated that rewarding themselves after hard work is a way to motivate themselves, so including rewards in the app as a type of motivation is critical.

Playing mobile/video games is one of the strategies some participants tend to use as a way of distracting themselves from current negative feelings and as a way of entertaining them. So, including simple games in the app is important to entertain users and distract their attention from negative thoughts. Additionally, including relaxation exercises and audio clips in the mental health app will bring participants some relief.

Participants have different ways of using mental health apps. Some people prefer to use them only when they are in a crisis: From their perspective, the app should have specific components that help them relax and calm down. Alternatively, others would like to use the app on a daily basis: They suggested a variety of ideas to motivate them to use the app daily, such as reminders, tracking, and so on. Table 4.3. shows the implementation ideas that emerged from focus-group study.

Table 4.3 Implementation ideas that emerged from the focus-group study prioritize the list numbers for each category based on importance

<b>Design Suggestions</b>	<b>Implementation</b>
Track personal data to improve mental health	Predicting emotions based on the auto-tracking of their sleep, heart-rate, breathing-rate, and phone-use data. Auto-tracking of users' sleep time, heart rate, time spent on the phone, and in-app achievements. Tracking of mood and other factors that can contribute to mental health issues. Tracking of user's notes and successful personal solutions. Tracking users' alcohol consumption rate.
Provide access to a social community group	Having different groups created based on mental health or life issues. The ability to create a group for specific issues and inviting people. The ability to follow any one of these groups by searching for issues users are facing.

<b>Design Suggestions</b>	<b>Implementation</b>
	<p>Ensuring and maintaining users' anonymity while communicating in the social community.</p> <p>Providing an assessment questionnaire to direct users to the right group.</p> <p>Including one-on-one chatting in-app via sending a request and, if the request is accepted, users can chat together.</p> <p>The ability to post a picture in the group.</p> <p>The ability to make a video/voice call.</p> <p>Adding some basic rules to the community, such as respect and prohibit threats or bullying.</p> <p>Adding a block option to block undesirable contacts.</p>
Provide motivational content	<p>Including positive news available in different formats (such as text, audio, and video).</p> <p>Including positive motivational quotes or statements that are updated regularly.</p> <p>Providing religious inspirational quotes and inspirational stories.</p> <p>Providing rewards after any accomplishment to motivate users to keep using the app.</p>
Personalize the app's styles and functions	<p>The ability to customize reminders, background, colour, and music.</p> <p>Providing an assessment before using the app to personalize the app's content based on users' answers. However, this assessment must be short.</p> <p>A personal app greeting (greeting users by name).</p> <p>Providing users with solutions based on selected feelings or issues.</p> <p>Providing music and/or religious phrases based on what the users are currently feeling.</p>

<b>Design Suggestions</b>	<b>Implementation</b>
	The ability to add personal strategies in their profile so the app can make personalized suggestions when they experience a crisis.
Provide reminders and notifications	<p>Sending periodic notifications to check on users, either randomly or at user-defined times.</p> <p>Reminding users to track their mood and activities.</p> <p>Notifying users about their feelings based on their tracked personal data.</p> <p>Reminding users of positive things in general and good things happening in their lives as a way of redirecting their attention from the negatives.</p> <p>Notifying users if they have made progress towards overcoming their mental health issues by showing motivational messages.</p>
Provide suggestions for the users	Providing suggestions on what to do based on their feelings or auto-sensed data related to their current circumstance. These suggestions can be positive articles, health advice, strategies to overcome the mental health issue, personal strategies that were previously recorded to make users feel better, or advice for the user to contact a doctor
Allow ability to generate report	Providing a summary report of their data and/or progress which can be shared with their therapist.
Include games to distract and entertain them	<p>Including a simple game (such as a puzzle or a focus on positive words) in the mental health app for distracting users' attention from their current (negative) mood and entertaining them.</p> <p>Including also simulative games such as memory cards, online games with other participants,)</p>

<b>Design Suggestions</b>	<b>Implementation</b>
Provide goal setting	The ability to set up health-related goals and show users how many days they have left to complete their goal.
Provide relaxation exercises and audio clips	<p>Providing relaxation exercises such as breathing, meditation, gratitude, recording thoughts, CBT, forgiveness, and yoga exercises.</p> <p>Including relaxation audio such as music, natural sounds, worship, and religious audio clips</p>
Provide a doctor or therapist, family, and friends as contacts for external support	<p>Providing a suicide crisis hotline.</p> <p>Allowing users to provide contact details for friends and family to contact for support when necessary.</p> <p>Allowing users to contact a doctor or therapist in their area.</p> <p>Providing Google Map functionality that shows available therapists and communities for mental health support near the users.</p> <p>Providing live therapists and coaches who can respond to their concerns.</p> <p>Providing users with a way to contact a stranger through the app.</p>
Include personal assistance in the app	Providing individualized emotional support, assessment, and advice based on their recorded data using artificial intelligent.
Improve the privacy and security of the app	<p>Asking permission to access the user's photos, contacts, and so on.</p> <p>Including a clear privacy policy that shows how their data will be protected.</p> <p>Offering a lock feature in the mental health app to protect users' collected data and information.</p>

<b>Design Suggestions</b>	<b>Implementation</b>
	<p>Offering an option for an individual mode, as opposed to an online community mode, where they can make personal notes and express their feelings within the app privately.</p> <p>Providing users with the option to use the app without creating an account.</p>
<p>General design preferences</p>	<ul style="list-style-type: none"> <li>• Usability <p>Making the app easy to use and easy to navigate.</p> <p>Including instructions on how to use the app</p> <p>Making the home screen organized to simplify it.</p> </li> <li>• Content <p>Providing a variety of activities</p> <p>Updating the app’s content regularly.</p> <p>Providing credible information.</p> <p>Creating app content that shifts users’ attention away from their current issues.</p> </li> <li>• Basic design <p>Making the colour scheme of the app bright and calm.</p> <p>Making the purpose of the app clear.</p> <p>Including a profile and favourites lists.</p> <p>Making account creation optional or offering a choice to sign up with Facebook or Google account.</p> <p>Making the app’s name simple and not including any mental health issue in the name.</p> </li> </ul>

## 4.6 Chapter Summary

This study aims to develop and evaluate the effectiveness of a mental health mobile app for promoting mental health. Findings from this study generated insight into people's perspectives, opinions, and preferences on the use of mobile apps to support mental health and how such apps should be designed.

Through the three-phase study with 32 participants which involved the phases of exploring users' experiences with mental health issues; understanding participants' perspectives, opinions, and preferences in relation to two selected mental health apps; and a co-designing session, I identified 14 unique feature ideas and generated 32 participant design sketches of an ideal mental health app. My findings revealed that participants were using some strategies to deal with their mental health issues: 1) doing something to distract themselves from their current negative mood, 2) using relaxation exercises and methods to relieve symptoms, 3) interacting with others to share their issues, 4) looking for an external source to solve their problem, and 5) motivating themselves by repeating motivational sentences to support themselves or by following inspirational people. Moreover, regarding the design of the mental health app, participants identified that the 1) usability of the app, 2) *personalization of the app, including* 3) *tracking and feedback, 4) live support, and 5) social community, and providing* 6) *motivational content* and 7) relaxation exercises are the most important features users want in a mental health app. In contrast, *including* 8) *games, 9) relaxation audio, 10) the Google map function, 11) personal assistance to provide suggestions, 12) goal setting, and 13) privacy preserving* were surprisingly the least requested features. Understanding end-users' needs and concerns about mental health applications will inform the future design and development of mental health apps that are usable, useful, accepted, and successfully used by the target audience to promote mental health and emotional well-being.

In this chapter, I presented the results of a focus-group study that was conducted to uncover the users' opinions, perceptions, preferences, and experiences to inform the design of a next-generation mental health app. In the next chapter, I build a personality-based model-driven approach by conducting a large-scale study of 561 participants to evaluate the

persuasiveness of the common persuasive strategies/features that emerged from Chapters 2, 3, and this chapter, based on user's personality traits.



## CHAPTER 5: BUILDING THE PERSONALITY-BASED MODEL-DRIVEN APPROACH

*Chapter overview:* Chapter 4 presents the results of the focus-group study that was conducted to understand the users' opinions, perceptions, preferences, and experiences to inform the design of a next-generation mental health app that would be substantially more engaging and effective than the currently available apps to improve mental health and well-being. This chapter shows the results of relationships between personality traits and the common persuasive strategies/features that emerged from Chapters 2, 3, and 4. Moreover, it presents the findings of possible domain-dependent variability in the relationship between personality and persuasive features across various domains <sup>4</sup>.

### 5.1 Motivation of this Work

Research has shown that the effectiveness and preference of persuasive features often employed in these app may be dependent on the domain of application [167]. A persuasive feature that works in one domain for a particular type of user may not work for the same type of user in another domain. Considering the sensitive nature of mental health issues, research specifically targeting at investigating the effectiveness of persuasive features in the mental health domain is needed. Mental health apps may be more effective if they are tailored to various user characteristics. Research has revealed that people differ in their motivation; hence, different types of individuals are motivated by distinct persuasive features, and what motivates one group of users may demotivate others [166],[105]. As a result, several studies of health apps have emphasized the need for more insight into

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<sup>4</sup> Originally published in **Alqahtani, F., Meier, S., & Orji, R. (2022).** Personality-based approach for tailoring persuasive mental health applications. *User Modeling and User-Adapted Interaction*, 32(3), 253-295.

various user characteristics that should be considered when tailoring persuasive interventions [169], [177],[175].

## **5.2 Personalizing Persuasive Applications**

Personalizing persuasive app is an act of adapting the app features and/or functionalities to the target users or user groups [175], [161]. Personalizing the persuasive features employed in app design is important to improve their effectiveness in promoting the target behaviour compared to generic apps [169],[166]. However, without knowing the end-user characteristics and context, tailoring persuasive apps to achieve the intended objective is difficult. The importance of personalizing persuasive apps has been highlighted in various studies. For example, Ciocarlan et al. [47] conducted six focus groups with 35 participants to investigate how to tailor game interactions, activities, and challenges. They found that participants emphasize the importance of personalization (both implicit and explicit) in a game-based intervention for mental well-being. Moreover, analyzing the user reviews of mobile mental health apps shows that personalization functionalities are among the top app features that are well received by users [47].

There are two major ways to personalize mobile apps: implicit profiling or explicit profiling [104]. In implicit profiling, the persuasive apps are adapted based on interactions with the user. For example, the mobile phone app, ‘MYPLAN’, which manages crises, is a good example of implicit profiling, where tailoring is achieved by providing individualized coping strategies based on users' symptoms of a suicidal crisis [18]. Other studies have used machine learning to select appropriate moments for health message delivery [158]. However, in explicit profiling, prior research on measuring individual differences in responses to persuasion, user attitudes, preferences, beliefs, characteristics, or personality traits [104] can be used to inform personalization.

A few studies have attempted to identify the most effective persuasive features to tailor persuasive interventions based on one or more characteristics of the end user to increase the adherence and overall effectiveness in terms of promoting target behaviour. These studies have focused on tailoring apps based on various characteristics, including gender [38], [165], [2] age [165],[2], culture [163],[180], gamer type [175],[177],[166],[235], and

personality traits [169], [80],[204], [97], [182], [50], [17]. All these studies have arrived at the same conclusion: end-user characteristics should be considered when choosing the most suitable persuasion feature for an individual. Therefore, understanding individual differences in response to persuasive features plays a critical role in improving the effectiveness of persuasive apps and user adherence. Despite these past studies, there is a lack of studies on how persuasive mental health apps can be tailored. My study fills this gap. This study also shows that the relationship between personality and persuasive features vary across various domains could be domain-dependent, see Tables 5.1 and 5.6

Table 5.1 Summary of research on personality and persuasive features across domain (+) representing the positive correlation, and (-) representing the negative correlation.

Authors	Domain	Features	Personality traits				
			EXT	AGR	CON	NEU	OPE
Jia et al. [97]	Healthy habit formation	Points	+			-	
		Badges				-	
		Level	+		+		
		Progress			+	-	
		Social Comparison and competition	+				
		Challenges		+			
		Avatar					-
		Rewards				-	
Halko et al. [80]		Social role					+

Authors	Domain	Features	Personality traits				
			EXT	AGR	CON	NEU	OPE
	Physical fitness	Cooperation			-	-	
		Competition		+	+		+
		Trophies	-				-
		Intrinsic motivation	-				-
		Remove punishment	-	-		+	-
		Rewards	-	-			
Codish et al. [50]	Educational context	Badges (virtual reward)	+				
		Points (grade points)	+				
		Rewards (physical rewards)	+				
		Self-monitoring and feedback	+				
		Social Comparison and Competition	-				

Authors	Domain	Features	Personality traits				
			EXT	AGR	CON	NEU	OPE
Anagnostopoulou et al. [17]	Transportation habits	Social Comparison		+		+	
		Self-monitoring		+	-	+	
		Suggestion		+		+	
		Simulation		+		+	
		Cooperation		+			
		Praise		+		+	
		Personalization	-	+		+	
		Competition				+	
Oyibo et al. [182]	Social behaviours	Social Learning			-	+	+
		Social Proof (Normative Social Influence)			-		
		Social Comparison				-	-
Orji et al. [169]	Risky alcohol behavior	Personalization	+	+	+		+
		Cooperation	+	+			-

Authors	Domain	Features	Personality traits				
			EXT	AGR	CON	NEU	OPE
		Simulation	+	+	+		
		Self-monitoring and Feedback	+	+	+		-
		Social Comparison	+	+			-
		Punishment	+	+			-
		Goal Setting and Suggestion	+		+		
		Customization	+	+			-
		Competition	+	+			-
		Reward	+	+			-
Shuttleworth et al. [204]	Physical activity	Social comparison				+	
		Recognition				+	
		Social facilitation				+	
		Social learning					
		Competition				+	
My results	Mental health	Relaxation Exercise	+	+		+	+

Authors	Domain	Features	Personality traits				
			EXT	AGR	CON	NEU	OPE
		Self-monitoring	+	+			+
		Reminder	+	+			-
		Relaxation Audio	+	+	+	+	+
		Verifiability	+		+		-
		Contact for Help	+	+	+	+	
		Social Support	+	+		+	+
		Security feature	+	+			-
		Suggestion	+	+	+		-
		Personalization	+	+			-
		Distraction	+	+			
		Rewards	+	+		+	-
		Encouragement	+	+	+		-
		Credibility	+	+		+	-
		Praise	+	+			-
		Customization	+	+	-		-

Authors	Domain	Features	Personality traits				
			EXT	AGR	CON	NEU	OPE
EXT extraversion, AGR agreeableness, NEU neuroticism, CON conscientiousness, OPE openness							

### 5.3 The Objective of the Work

The aim of this work is twofold. First, I explore the relationships between personality and features of a persuasive app for promoting mental and emotional well-being. Second, I explore possible domain-dependent variability on the relation between personality and persuasive features across various domains (e.g., habit formation, fitness, risky behaviours change, transportation habits).

### 5.4 Study Design and Methods

I implemented the common strategies/features that emerged from stage 1 (Chapter 1 and 2) and stage 2 (Chapter 3) in persuasive app prototypes for promoting mental health. and conducted a large-scale study of 561 participants to evaluate their persuasiveness. Persuasiveness is a term used to describe an intervention's ability to motivate behavior change [174]. The perceived persuasiveness of a persuasive feature or a system is an estimation of its ability to promote the desired behavior [174]. This study focuses on reporting the findings from the large-scale study to answer my research questions of *how can, persuasive apps for mental health be tailored to various users' personalities to improve their effectiveness*. The strategies/features of a persuasive mental health app included in this study and the corresponding descriptions are listed below.

**Encouragement:** Offers supportive messages and positive motivational quotes, such as “Believe you can and you are halfway there”, “Be Strong!”, and so on. Integrating motivational quotes into various interventions has been shown to increase confidence, motivation, and empowerment in people struggling with mental health issues [141].



**Personalization:** Provides personalized content and services for users. Based on the user profile, the app greets the user by name and provides a personal suggestion to improve his/her mood. According to Orji [170], the ability to modify the intervention delivered via health apps to be suitable for the user's needs makes the intervention more effective than the one-size-fits-all approach.

**Customization:** Allows users to customize the app appearance and other functionalities in the app, such as creating a list of their favourite audio sounds, changing the audio volume, disabling/enabling notifications, changing app appearance, and so on. Price et al. [185] found that participants preferred to customize some aspects of the app, such as colour and background, which allows for autonomous use and tailoring.

**Self-monitoring:** Tracks personal data and presents a visualization of the collected user data to improve the user's awareness and understanding of their past and current states. Research has shown that self-monitoring is considered the main feature of many psychological therapeutic techniques, such as cognitive-behavioural therapy and emotion-focused therapy and helps improve the users' awareness of what influences their feelings, thoughts, and behaviours [24].

**Rewards:** Offering rewards after any accomplishment motivates users to continue using the app and improves their emotional well-being. Orji et al. [176] showed that rewards, such as badges and points, are effective at encouraging and engaging users in their behavioural change activities.

**Praise:** Praising users for successfully completing a behaviour-related task to motivate them to continue using the app to achieve their behaviours change objectives. For example, the message "well done, you made good progress toward your goal today!" is presented to users after finishing their meditation exercise. Praise is among the popular persuasive features employed in many health apps to encourage users to be more engaged [177].

**Reminders:** Helps users to stay emotionally healthy by reminding them to engage in various personalized wellness and mental health-related activities, such as meditation and relaxation-related exercises. Research has revealed that reminders are effective at promoting behaviour and enhancing adherence. For example, Clarke et al. conducted a

randomized control trial with a usual treatment control group and two self-help website intervention groups receiving reminders. They found that the self-help website intervention with reminders increased the frequency of participant visits to the website intervention compared to their previous study that used the same intervention without reminders [49].

**Social support:** Allows users to discuss their issues and feelings with people having the same or similar issues, and they could remain anonymous while doing this. Social support from peers and coaches has been shown to reduce the psychological effects of mental health issues and has a positive effect on the quality of life [199].

**Suggestion:** Suggests ways of improving the user's current low mood and other mental health-related situations based on evidence of what works.

**Credibility (privacy policy):** Provides information about how developers handle user data and keep the data confidential. According to Alqahtani et al. [13], the privacy issue reduced the credibility of mental health apps and affected user trust.

**Verifiability (trusted information):** Providing information about mental health from trusted and credible external sources improved trust and, hence, effectiveness via adherence.

**Distraction:** Provides a variety of distraction exercises, such as games, puzzles, and funny jokes to entertain users and distract them from the current negative mood, thought, or feeling.

**Relaxation exercises:** Provide a variety of exercises for symptom relief, such as meditation, breathing exercises, yoga, and gratitude. Previous research has shown that relaxation exercises, such as deep breathing [146], mindfulness [91], and gratitude [76], positively influence emotional well-being and physical health.

**Relaxation audio:** Provides audio, such as music, natural sounds, and religious worship audio to relax people and reduce stress, depression, and anxiety. Research has revealed that listening to music or natural sound before [216] or after [16] a stressful task reduces the stress effects.

**Security:** Allows users to secure the app from any external access by creating a password. This would increase user trust and engagement with the app. The lock/pin feature is one of the features users appreciate in mental health apps [13].

**Contact for help:** Allows users to contact a therapist and call a friend or family member directly from the app. It also allows users to find a counsellor or health and wellness society in their area. This allows them to reach out for support when necessary, in line with social roles. According to Dirkzwager et al. [61], support from friends or family helps people with mental health issues cope with their conditions and avoid isolation.

#### 5.4.1 Study Instrument

The study instrument consists of the following three parts.

**Demographics:** I collected demographic information of participants' age, gender, level of education, experience with mental health apps, whether they have experienced any form of mental health issues based on self-diagnosed.

**User Personality traits:** I also collected data to assess each participant's personality using the 10-items personality traits scale (BFI-10) [186]. Each statement was assessed using a 5-point Likert scale ranging from "1 = Strongly disagree" to "5 =Strongly agree" to measure users' agreement.

**Persuasive feature preferences:** I followed an established approach that has been used by other HCI researchers [169],[175],[177],[97],[222]. Specifically, I provided each participant with prototype implementations of mental health apps operationalizing individual features in their design. In total, I developed 16 prototypes representing the 16 persuasive features in this study using Balsamiq [27]. I evaluated the persuasiveness of the 16 features by presenting a prototype implementation that demonstrates each feature.

Each prototype implementation consists of one or two screen designs representing each feature as a scripted interaction between the user and the proposed mental health app. I also provided detailed descriptions of the prototype for each persuasive feature. The prototypes were designed following several iterations and pilot evaluations, including design discussions with a group of 12 HCI researchers, who are knowledgeable in the

research area. Based on their feedback and discussions, I refined the final versions of the prototypes that clearly describe the individual feature and are easy to understand by the targeted audience.

Figures 5.1 present two of these prototypes (representing the relaxation exercises and self-monitoring) as examples. To prevent possible bias because of the prototype order in the survey, I used a Latin square to balance the order of presentation of the features. I used the rotation functionality of Opinio software that varied the position of the features for each participant. I used the perceived persuasiveness scale to obtain feedback on the perceived effectiveness of each persuasive feature. Each prototype was followed by a perceived persuasiveness scale, which is a validated instrument and was adapted to mental health and emotional well-being from [177]. It also has been used in other previous persuasive studies [169],[38],[177],[17],[160]. The scale consists of four statements.

“This feature would influence me to take care of my mental health and emotional well-being.”

“This feature would convince me to be mentally/emotionally healthy.”

“This feature would be personally relevant for me.”

“This feature would make me reconsider my mental healthcare and emotional well-being.”

These scales were measured using a 7-point Likert scale ranging from 1 = strongly disagree to 7 = strongly agree. I also included an open-ended question allowing participants to provide comments to justify their choice/ratings and what they liked or disliked about this feature. This ensured that participants were actively considering their responses as opposed to providing random responses. It also ensured that participants took the time to consider each feature carefully before responding.

Participants completed the survey anonymously and, prior to participation, I presented the participants with an informed online consent form. In addition, I included several attention-check questions in the survey to ensure participants were reading all the items carefully and actively considering their answers. Responses from participants who incorrectly answered the attention questions were not included in the analysis.

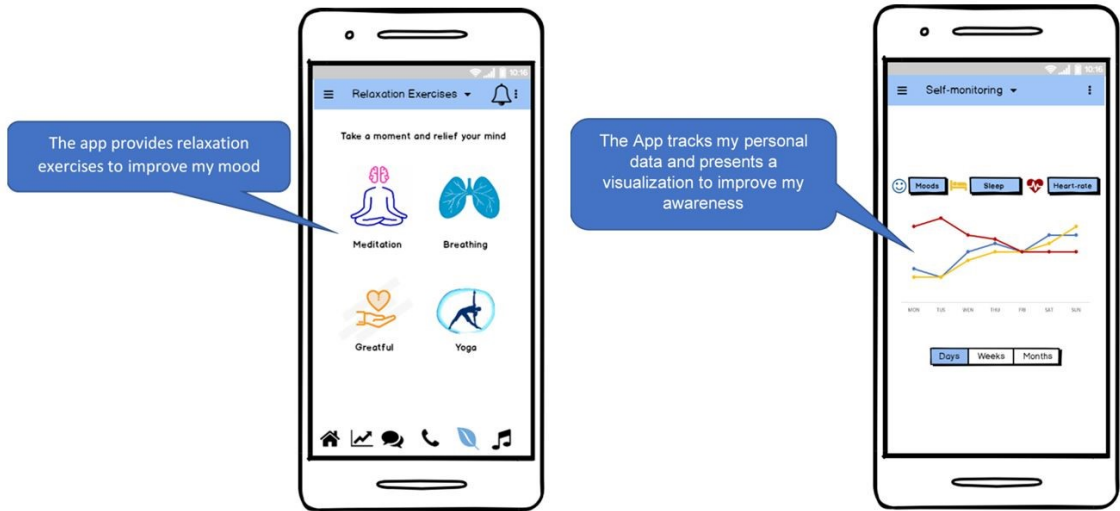


Figure 5.1 Prototype of the feature "relaxation exercises" and "self-monitoring"

### 5.4.2 Participants

The participants in the survey study consist of people who have experienced stress, low mood, depression, anxiety, panic attacks, and other forms of mental health-related issues based on self-reports, not clinical diagnoses. I included 561 in this analysis (500 from AMT and 61 from other social networks and email) after I filtered out incomplete responses and incorrect responses to the attention-check questions. The results of the analysis revealed that 341 (61%) of the participants in the study had used an app to manage their mental health issues in the past. I had a relatively diverse population in terms of gender, age, and education level (Table 5.2). However, most of my participants are young adults between 18 and 35 years of age and are relatively educated.

Table 5.2 Demographics information

Gender	Male (47.24%), Female (52.59%), Other (0.18%)
Age	18-25 (19.96%), 26-35 (46.35%), 36-45 (17.11%), 46-55 (8.56%), Over 55 (8.02%)

Level of Education	High School or equivalent (13.73%), College diploma (6.60%), Bachelor's degree (58.11%), Master's degree (18.54%), Doctoral degree (1.78%), Other (1.25%).
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### 5.4.3 Data Collection

To collect data for the study, I conducted a large-scale online study. I recruited participants for this study using different approaches. I recruited participants by email (from both academic and non-academic environments) and from social networks (Facebook, and Twitter). I also used Amazon Mechanical Turk (AMT) for two main reasons. First, I needed numerous participants and a diverse audience for my study. Second, AMT has become an accepted method of collecting responses from diverse participants [88], [97], [169],[177]. I also conducted two pilot studies before the main study. The first pilot study was conducted on five people from the university, and the second was on 10 participants from AMT to test the understandability and the validity of my study tool.

### 5.4.4 Data Analysis

I used several well-known analytical tools and procedures that have been employed in several research studies [166]. In this section, I summarize the various steps taken to analyze the data.

I calculated the descriptive statistics for demographic variables.

I determined the suitability of the data for analysis by assessing the Kaiser-Meyer-Olkin (KMO) sampling adequacies and the Bartlett test of sphericity [102] using SPSS.

I examined and compared the persuasiveness of the features by computing the average score for each feature and conducting a repeated-measure analysis of variance (RM-ANOVA) followed by pairwise comparison after validating for the ANOVA assumptions using SPSS.

Finally, I used the employed the Partial Least Squares (PLS) Structural Equation Modeling (SEM) (PLS-SEM) [191] to develop models showing the relations between the personality traits and the persuasiveness of various features. I used SmartPLS 3 for SEM (see Figure

5.2) which is the recommended approach for modeling relationships between variables [121].

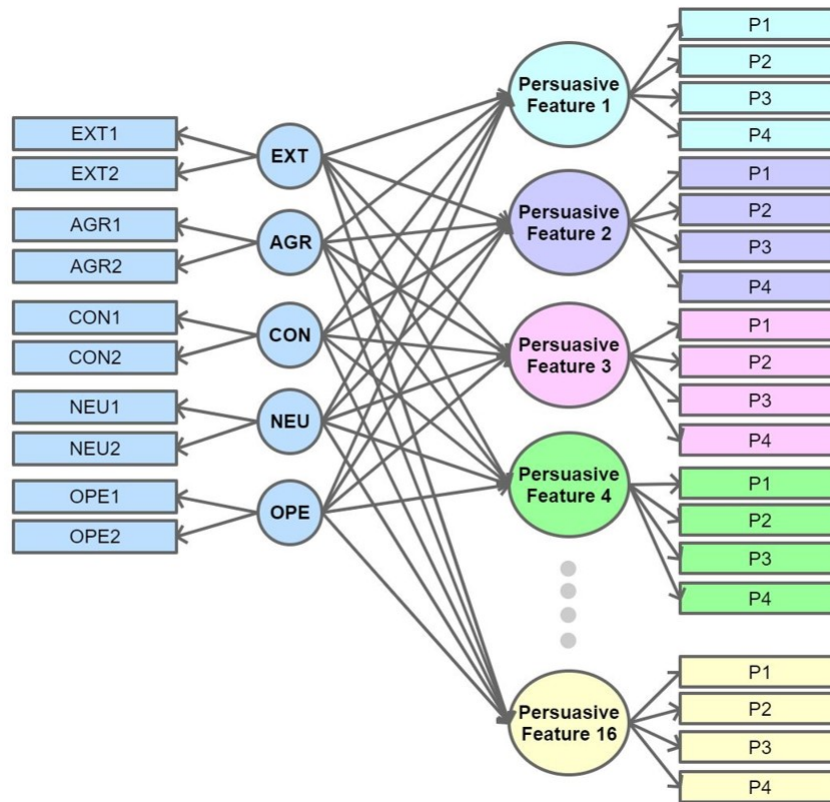


Figure 5.2 PLS-SEM model structure

#### 5.4.4.1 Assessing the Suitability of Data

I determined the suitability of my data for further analysis using the KMO sampling adequacies and the Bartlett Test of Sphericity. The results show that the KMO was 0.951, well above the recommended value of 0.6; that the Bartlett Test of Sphericity was statistically significant ( $\chi^2(3003) = 43,427.379, p < 0.0001$ ). These results show that the data was suitable for further analysis [121].

#### 5.4.4.2 Measurement Model

I measured the validity and reliability in the PLS-SEM model using the following set of criteria.

**Indicator Reliability:** I examined the indicators loadings of the models and they were all above the recommended value which is 0.708 [44].

**Internal Consistency:** I assessed the internal consistency and reliability using composite reliability (CR) and Cronbach's alpha and all were higher than their threshold value of 0.7 [44].

**Convergent Reliability:** I also checked the data for convergent reliability by assessing average variance extracted (AVE) and all constructs have an AVE above the recommended threshold of 0.5 [44].

**Discriminant Validity:** I assessed discriminant validity using the Heterotrait-Monotrait (HTMT) ratio of correlations and found that HTMT was all below the recommended limit of 0.9 [44].

## 5.5 Results

In this section, I first present the results of comparing the overall persuasiveness of the features. Then I present the results of the relationship between the FFM personality traits and the features of a persuasive app. I also present a comparative analysis of personality traits targeting various domains to show that the effectiveness of the features for various personalities is domain-dependent.

### 5.5.1 Comparing the Persuasiveness of the Features Overall

The results of repeated-measure ANOVA show significant main effects of the features type of a persuasive app on persuasiveness ( $F(12.475, 6985.861) = 21.404, p < .0005$ ) overall. This suggests that there are significant differences between the features of a persuasive app with respect to their overall persuasiveness. A Bonferroni-corrected pairwise comparisons shows that in general, relaxation exercise, self-monitoring (listed in decreasing order of persuasiveness), emerged as the most features of a persuasive app (both are significantly different from other features; however, self-monitoring is not significantly different from reminder). On the other hand, personalization, distractions, rewards, encouragement, credibility (privacy policy), praise, customization emerged as the least features of a persuasive app. In other words, my participants have least preference



for these features compared to other features. The rest of the features (reminder, relaxation audio, verifiability (trusted Information), contact for help, social support, security, suggestion) are in the middle, with reminder leading the list (see Table 5.3).

Figure 5.3 presents the notched boxplot of the 16 features of a persuasive app, with each notch representing 95% confidence interval of the median. In general, the 16 features of a persuasive app were perceived as persuasive, with persuasiveness score significantly higher than the neutral rating of 4 ( $p < .001$ ), indicated by the blue horizontal line in Figure 5.3.

In summary, although participants found all the 16 features of a persuasive app to be effective (because of higher persuasiveness scores), relaxation exercises and self-monitoring were perceived as the most effective features, while personalization, distractions, rewards, encouragement, credibility (privacy policy), praise, customization were perceived as the least effective features, listed in decreasing order of persuasiveness

Table 5.3 Means and standard deviations of the overall persuasiveness of the 16 features of a persuasive mental health app

<b>Features</b>	<b>Mean</b>	<b>Std. Deviation</b>
Relaxation Exercises	5.54	1.17
Self-Monitoring	5.48	1.21
Reminder	5.35	1.27
Relaxation Audios	5.31	1.37
Verifiability	5.27	1.27
Contact for Help	5.18	1.37
Social Support	5.12	1.53
Security feature	5.09	1.48
Suggestion	5.08	1.41

Features	Mean	Std. Deviation
Personalization	5.02	1.47
Distractions	5.01	1.54
Rewards	5.01	1.50
Encouragement	5.00	1.58
Credibility	4.99	1.46
Praise	4.94	1.55
Customization	4.87	1.46

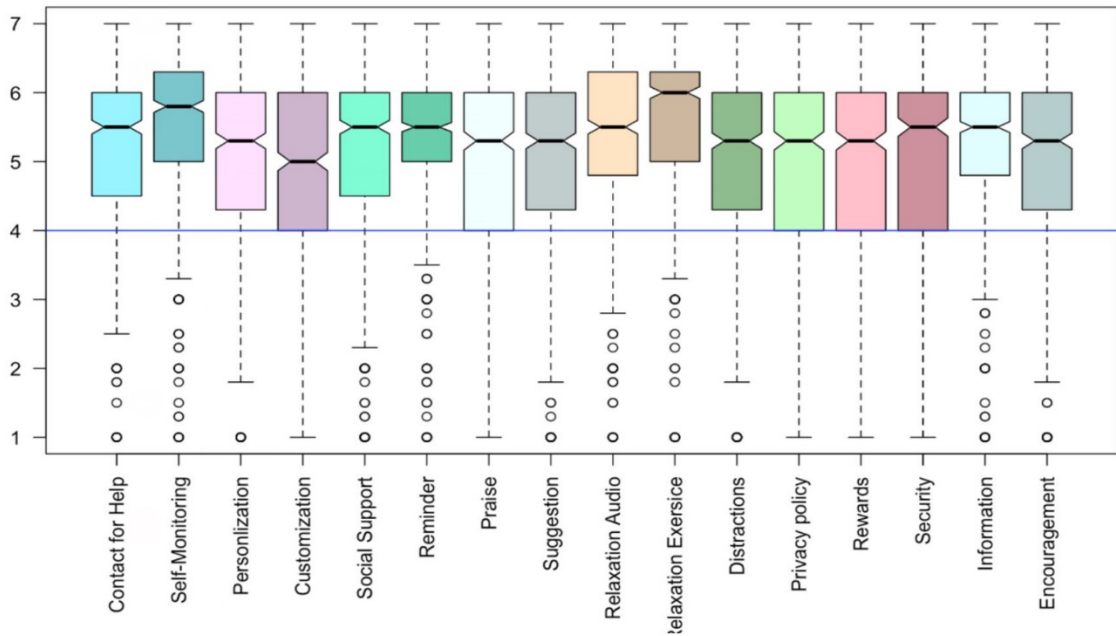


Figure 5.3 The boxplot shows the overall persuasiveness (y-axis) of the 16 persuasive features (x-axis) on a scale of 1 to 7. The higher the rating, the higher the persuasiveness. The neutral rating is represented by the blue horizontal line

### 5.5.2 The Structural Model

I used the structural models to determine the relations between the participant’s personality traits and the persuasiveness of individual features of a persuasive app. Figure 5.2 shows the PLS-SEM model structure. I assessed the level of the path coefficient ( $\beta$ ) and the significance of the path coefficient (p) which are the two important criteria to measure the strength of the relationships between variables in structural models [169]. Path coefficients are used to measure the influence of a variable on another. I summarized the individual path coefficients ( $\beta$ ) and their corresponding level of significance (p) obtained from my models in Table 5.4.

Table 5.4 Standardized path coefficients and significance of the relationships. Bolded coefficients are  $p < .001$ , non-bolded are  $p < .05$ , and ‘-’ represents non-significant coefficients

Features	EXT	AGR	CON	NEU	OPE
Relaxation Exercise	.15	<b>.24</b>	-	.08	<b>.16</b>
Self-monitoring	.14	<b>.21</b>	-	-	.13
Reminder	.14	<b>.27</b>	-	-	-.10
Relaxation Audio	.10	<b>.21</b>	.12	.12	<b>.17</b>
Verifiability	.10	-	<b>.17</b>	-	<b>-.24</b>
Contact for Help	.11	<b>.18</b>	.11	.11	-
Social Support	.10	<b>.20</b>	-	.12	.11
Security feature	.16	.12	-	-	<b>-.21</b>
Suggestion	<b>.20</b>	<b>.18</b>	.10	-	<b>-.19</b>
Personalization	.13	.15	-	-	<b>-.15</b>
Distraction	<b>.20</b>	<b>.18</b>	-	-	-
Rewards	<b>.18</b>	<b>.23</b>	-	.14	-.10

Encouragement	.15	<b>.18</b>	.09	-	<b>-.19</b>
Credibility	<b>.19</b>	<b>.18</b>	-	.11	<b>-.16</b>
Praise	<b>.19</b>	<b>.23</b>	-	-	-.12
Customization	.15	<b>.19</b>	-.10	-	-.14
EXT = Extraversion, AGR = Agreeableness, NEU = Neuroticism, CON = Conscientiousness, OPE= Openness					

### 5.5.3 The Relationships between Personality Traits and Features of a Persuasive app

The results from the structural model reveal that the participant’s personalities impact the persuasiveness of individual features (see Table 5.4). In this section, I discuss and compare the persuasiveness of the feature for people of different personality traits.

#### 5.5.3.1 Relaxation Exercises

*Relaxation exercises* feature offers a variety of relaxation exercises for symptom relief that users can choose from, such as meditation, breathing exercises, gratitude, and yoga. Previous research has shown that relaxation exercises such as deep-breathing [146], mindfulness [91], and gratitude [76] positively impact emotional wellbeing and physical health. The results show that people who are high in extraversion, agreeableness, neuroticism and those who are open to experience are more likely to use relaxation exercises to improve their mental health and emotional well-being ( $\beta=.15, p<.05$ ), ( $\beta= .24, p<.001$ ), ( $\beta= .08, p<.05$ ), ( $\beta=.16, p<.001$ ) respectively. These findings are supported by participants' comments to justify their ratings.

For example, participants who are high in extraversion and agreeableness, neuroticism, and those who are open to experience have this to say about the relaxation exercise.

*"When many thoughts are going through my head, it will be nice to find a way to slow them down or quiet them"* [P31]<sup>5</sup>.

*"We are currently living in harsh conditions, so it is essential for the body to have the rest it needs"*[ P1].

The findings suggest that participants are motivated to use relaxation exercises because *it helps them to relax and escape from overwhelming thoughts*

On the other hand, *relaxation exercises* have no significant impact on people who are high in conscientiousness.

*The quality of relaxation exercises design and past experiences* of using relaxation exercises could impact how people perceived this feature.

*"It all depends on the quality of this stuff"* [P40]

*"I haven't found mindfulness exercises to be useful yet. They seem forced"* [P204].

### **5.5.3.2 Self-monitoring**

*Self-monitoring* feature tracks people's behaviours and shows them their past and current state and how it relates to their goals, hence improving self-awareness. The results show that self-monitoring is a significant motivator for people who are high in extraversion, agreeableness, and open to experience ( $\beta = .14, p < .05$ ), ( $\beta = .21, p < .001$ ), and ( $\beta = 0.13, p < .05$ ), respectively.

People gave some reason to justify their high preference for self-monitoring which include that self-monitoring provides an ability to *understand their feeling, be more conscious of*

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<sup>5</sup> Quotes from participants are included verbatim throughout the chapter, including spelling and grammatical mistakes.

*the things that can impact their mood, help them to improve their emotional state and motivate them to keep going.*

*“I think this would be the most beneficial for me out of all the other options. This would show how your mental health has been and may help you to **identify possible triggers** when there” [P 90].*

*“It shows me stats that I would care about. Would make me feel that I am being **more conscious**” [P14].*

*"Charting my progress is very important for me when trying to **develop better mental/emotional habits**. I think this feature would be helpful" [P128].*

*“It is always more **motivating** to see progress/moods/improvement in a graph or timeline” [P170].*

However, self-monitoring has no significant impact on people who are high in neuroticism and conscientiousness. The reasons given by these groups for the low preference of the self-monitoring feature *include privacy concerns and discouraging due to negative emotions.*

*“It would be **discouraging to see I was unhappy for 3 days or that I had not kept up with my yoga**” [P111].*

*“I would wonder **who else is viewing my personal information besides me**, so, I might not provide completely accurate info” [P340].*

### **5.5.3.3 Reminders**

*Reminders* feature allows a system to remind the user to perform the target behavior. The results reveal that people with higher levels of extraversion and agreeableness preferred the reminders feature ( $\beta=.14$ ,  $p<.05$ ) and ( $\beta= .27$ ,  $p<.001$ ) respectively, while people who are high in openness perceived reminders negatively ( $\beta= -.10$ ,  $p<.05$ ). Some of the reasons for the high preference for *reminders* from the comments include the fact that reminder *help users to stay committed with the health behaviour, and reminding them to use the app to perform mental health-related activities especially during busy times.*

*“This would **help me to stay in practice of health**. Would be great to have this. We all need a reminder every once and again” [P141].*

*“I need **reminders to remember** to do things and make time for myself, otherwise, I can easily get lost in work and other daily tasks. So, this is a must for me” [P235].*

The reason given to justify the low preference and negative association with reminders by people high in openness is that *reminder can be overwhelming*.

*"I usually turn my notifications off because **loud noises trigger me** so I don't think a reminder would be effective for me" [P50].*

*"I would just get **more irritated** at having yet another reminder to go off, telling me I have to do something." [P62].*

#### **5.5.3.4 Relaxation Audios**

*The relaxation audios feature provides music, worship religious audios sound, and natural sound to soothe people's moods and emotions. The results show that relaxation audio is significantly associated with all personality traits but at different degrees. Relaxation audios are significantly preferred by people who are high in extraversion, agreeableness, conscientiousness, neuroticism and open to experience ( $\beta = .10, p < .001$ ), ( $\beta = .21, p < .05$ ), ( $\beta = .12, p < .05$ ), ( $\beta = .12, p < .05$ ) and ( $\beta = .17, p < .001$ ) respectively. In fact, the *relaxation audios* feature is the only feature that is positively associated with all personality traits.*

Some reasons given to justify the high preference for relaxation audios by all include that *it helps to distract from a current negative state and improve the overall mental health*.

*"It would be good to **distract** myself from the current problems" [P145].*

*"I think this would help to improve the mood in certain circumstances which could **help to improve overall mental health**" [P90].*

#### **5.5.3.5 Verifiability (trusted Information)**

The app provides ways to verify the accuracy of mental health information contained in the apps through trusted outside sources. The results indicate that verifiability is likely to

motivate behavior towards improved mental health for people who are high in extraversion, conscientiousness, and those who are less open to experience ( $\beta = .10, p < .05$ ), ( $\beta = .17, p < .001$ ) and ( $\beta = -.24, p < .001$ ) respectively. However, verifiability has no significant impact on people who are high in agreeableness and neuroticism.

These results are supported by participants' comments to justify their ratings. For example, participants who have a high level of extraversion and conscientiousness have this to say about the trusted information:

*"Sometimes you don't understand what is going on inside your own head. **It would be nice to have the information at my fingertips**" [P5].*

*"Following the wrong info can actually cause serious harm. **Having a trusted source on the ready is great**" [P19].*

#### **5.5.3.6 Contact for Help**

*Contact for help* feature allows users to contact a therapist and call a friend or family especially in moments of crisis. It also allows users to find a counselor or health and wellness society in their areas. The findings show that it is a highly preferred feature for all the personality traits except for curious, and imaginative people (openness) that shows no significant association.

Table 5.4 shows that extraversion, agreeableness, conscientiousness, and neurotic people perceive the contact for help feature as positive ( $\beta = .11, p < .001$ ), ( $\beta = .18, p < .05$ ), ( $\beta = .11, p < .01$ ), and ( $\beta = .11, p < .05$ ) respectively. Participants provided some reasons to justify their high preference for contact for help feature. These reasons include that it encourages them to seek help, share emotions, and could save lives.

*"This feature **would encourage me to seek help if I need it**. This feature legitimizes the need to take care of my mental health" [P144].*

*"This is very important for those who are experiencing intense emotional moods. This is a great feature that **could possibly change lives or save lives**" [P85].*



*“I like this app, during depression, normally I like to talk to someone. By talking to someone I can freely share my feelings”* [P148].

Some reasons for the low preference for contact for help by some participants is that they see this feature as being redundant since they are able to do it without an app and this feature may not fit in their insurance plan.

*"Google, or your phone contacts, should have all of this information. It's redundant"*[P151].

*“I do not need the app for this. It might also pick **therapists not in my insurance plan**”* [P141].

*“My Health care plan does not allow me to just call up my therapist, for example. I have to make an appointment even for a phone consult”* [P253].

### **5.5.3.7 Social Support**

“The design principles in the social support category describe how to design the system so that it motivates users by leveraging social influence” [81]. The findings show that including various forms of *social support* on mental health apps would motivate significantly all the personality traits except for people who are self-disciplined and dependable (conscientiousness) that shows no significant association.

As presented in Table 5.4, people with a high level of extraversion, agreeableness, neuroticism, and openness perceived positively the *social support* feature ( $\beta = .10, p < .05$ ), ( $\beta = .20, p < .001$ ), ( $\beta = .12, p < .05$ ), and ( $\beta = .11, p < .05$ ) respectively.

People shared some reasons to justify their high preference for social support features including that it *provides opportunities for them to get support from similar others, share information and talk to others anonymously, and helps reduce the feeling of loneliness.*

*“Getting support from people who've been through what you've been through is unparalleled to any other type of support. Being able to hear responses that have worked and being able to hear from someone else that's experienced tough situations makes the problems that seem so huge not such a big deal”* [P32].

*“An excellent feature that would be really useful for people that have no one to talk to about their issues or who just need to know that **they are not alone**”* [P66].

*“I am a shy person, so, talking with others **who would not know who I am would be comforting**. I think it would help me open up more”* [P284].

However, the reasons given by people who rate this feature low are that it has the tendency to waste people’s time, negatively impacting their well-being and that mental health is a private matter.

*“This feature is likely to **waste a lot of my time**. This feature would get me mixed up in other people's issues at my expense of energy and well-being”* [P53].

*“I feel like mental health is a private matter and **would not want to discuss it with random people**, who are not my therapist or friend/family”* [P77].

*“This feature depends on the personality type. **Introverts** may find little value in this feature”* [P530].

### **5.5.3.8 Credibility (Privacy Policy)**

Providing users with the privacy policy to show them how their personal data would be handled is a significant motivator for people who have a high level of extraversion, agreeableness, neuroticism and those who are less open to new experiences ( $\beta = .19$ ,  $p < .001$ ), ( $\beta = .18$ ,  $p < .001$ ), ( $\beta = .11$ ,  $p < .05$ ), and ( $\beta = -0.16$ ,  $p < .001$ ) respectively.

Some reasons to justify their high preference for the privacy policy in the app by these personalities include that *it helps them know how their personal data is handled and assures them that their sensitive information is protected*.

*“I think it’s important to know **how my data is being handled**. Especially when it concerns something like mental health which I don’t want to share with everyone”* [P22].

*“I like the privacy feature. It is necessary for any app, especially when you put **sensitive information on it**”* [P37].

On the other hand, the privacy policy is not as important for conscientious people. Participants mentioned that *they do not like to read the privacy policy and it will not be fully read.*

*“I get sick of reading all the legal mumbo jumbo of these privacy policies”* [P432].

*“Most likely privacy policy will **not be fully read**”* [P287].

It is worth mentioning that although having the privacy policy does not influence people to take care of their mental health and emotional well-being directly but helps in building users' trust and hence encourages them to use the app.

*“This 'privacy policy' feature is for the app and it won't influence or convince to take care of mental health. This feature will help whether we **can use this app safely or not**”* [P309]

### **5.5.3.9 Security Feature**

Offering a security feature such as a password to protect the app from any external access were perceived significantly positive by people who have a high level of extraversion, agreeableness, and less open for new experiences ( $\beta = .16, p < .05$ ), ( $\beta = .12, p < .05$ ), and ( $\beta = -.21, p < .001$ ) respectively. However, the security feature was not significant for people who are conscientious and neurotics.

The reasons given by participants to support the high preference for the security feature include that security feature *reduces worry about the privacy, makes people feel secure and safe, increases app reliability, and hence encourages them to use the app.*

*“Security is essential for this kind of app. **Reduces worry about privacy**”* [P220].

*“Password makes me **feel secure and makes the app more reliable**”* [P306].

*“Good feature as it would **encourage me to use the app** as I would not be concerned about others accessing/reading data about myself that is highly sensitive/personal”* [P 500].

Like the privacy policy, having security feature may not directly influence people to take care of their mental health and emotional well-being, however, it encourages them to use the app, ensuring them that their data is secure from any external access.

*“I don't think having a password would help me take care of myself better. The only thing I like about it is that other people **wouldn't be able to access my thoughts and feelings without knowing the password.**” [P88].*

### **5.5.3.10 Personalization and Customization**

Personalization and customization features represent two distinct ways of tailoring systems [177]. Personalization is always driven by the system whereas customization is often user-controlled [173]. It has been shown that tailoring becomes more effective when users are given some agency by allowing them to do at least some aspects of the tailoring for themselves. This is because allowing users to personalize the app to suit their preferences gives them a strong sense of control. This is the opposite of system-tailored contents (personalization) [212],[177] where the system automatically tailors the app contents based on the user's profile but without the user's explicit input or involvement. The results show that participants high in extraversion, and agreeableness and those who are less open to experiences perceived these two features the same. Both personalization and customization are preferred by people who are high in extraversion, agreeableness, and less open to experiences ( $\beta = .13, p < .05$ ), ( $\beta = .15, p < .05$ ), and ( $\beta = -.15, p < .001$ ) respectively; and ( $\beta = .15, p < .05$ ), ( $\beta = .19, p < .001$ ), and ( $\beta = -0.10, p < .05$ ) respectively (see Table 5.4).

However, the *customization* feature was negatively perceived by people who are high in conscientiousness ( $\beta = -.10, p < .05$ ), while *personalization* was not a significant motivator for people who are conscientious.

Some of the reasons provided by participants to justify their high preference for personalization include that *it makes the app more effective, provides users with more relevant and helpful content and suggests things that make users feel personally better.*

*“I like that it takes personal details into account. This makes **it more relevant to my situation**” [P59].*

*“This feature will help the end-user to get **suggestions related to their mental health** and will help to act accordingly” [P13].*

*“I like that it will prompt me to do things that will make me **personally feel better**” [P113].*

*“This feature is good because mental health is very personal. Personalizing the app would **make it more effective**” [P16].*

The reasons for low preference for personalization include that *some people feel that the app controls them if it tells them what to do and some are concerned about the security of their personal information used by the app to personalize contents.*

*“I wouldn't like an app to tell me what to do” [P225].*

*“I'd worry about my personal information being secure” [P326].*

Reasons provided by participants to justify the high preference for customization include that *it gives some control to users, making them feel the app belong to them and makes the app appealing.*

*“This customization feature **helps me to control the features related to the app** and help me to modify according to my needs.” [P322].*

*“This makes the **app appealing** to my eyes and thereby **encouraging** me to use this app” [P327].*

*“I feel this would lift my spirits. I would feel as if the **app is mine**. It would feel like the app is tailored specifically towards me” [P514].*

The reason given to justify the low preference for customization includes *it is not having a direct influence with respect to motivating people to be emotionally healthier.*

*“The feature that enables me to change the app color **would not affect or influence the way I see my mental health**. For me it is very unnecessary and that's why I disagree that it would somehow motivate me to be emotionally healthier” [P49].*

### **5.5.3.11 Suggestions**

In the *suggestion* feature, users receive recommendations or suggestions on how to improve or manage their mental health-related issues. The findings show that people who are high in extraversion, agreeableness, and conscientiousness perceived suggestions as a positive motivator to improve their mental health and emotional well-being, ( $\beta=.20$ ,

$p < .001$ ), ( $\beta = .18$ ,  $p < .001$ ), and ( $\beta = .10$ ,  $p < .05$ ) respectively. However, people who have a high level of openness perceived suggestions as a negative feature, ( $\beta = -.20$ ,  $p < .001$ ).

Based on participants' comments, people preferred the suggestion feature because *it's beneficial and it serves as a reminder to take care of their mental health especially for people who are not under any treatment.*

*"Having suggestions on how you can improve your mental health is a great idea **and would be very beneficial** to almost anyone especially those who aren't receiving treatment elsewhere".* [P520].

*"I believe this feature would **serve as a constant reminder for me to take care of my mental health.** It would help me cheer up often ... This'll help those who don't know where to turn to at the current time and need a boost."* [P250].

Others had a low preference for this feature because it may irritate them.

*"I think I would quickly **become irritated** with suggestions. I'd rather seek out helpful activities on my own"* [P185].

Some people expressed that their preference of the suggestion is based on the type of the suggestion they will receive and whether it is relevant to them or not.

*"I may like this feature. It would depend on the suggestions, and if **those were relevant to me**"* [P427].

So, others provided a solution to make the suggestions based on their choice (personalized the suggestion).

*"I'm not sure if these suggestions would help me. I want it **to be my choice**"* [P339].

### **5.5.3.12 Rewards**

In agreement with the reinforcement theory [207], The findings show that participants who are high in extraversion, agreeableness, and neuroticism, and those who are less open to experience perceived reward as a significant motivator ( $\beta = .18$ ,  $p < .001$ ), ( $\beta = .23$ ,  $p < .001$ ), ( $\beta = .14$ ,  $p < .05$ ) and ( $\beta = -.10$ ,  $p < .05$ ) respectively. Some reasons provided to justify this

high rating score include that *it gives a sense of accomplishment, increases confidence and self-esteem, it is fun, and it motivates users to practice and make progress.*

*"I like that it rewards you, in a way, to want better mental health. I like that it **feels like you are accomplishing something** by doing it" [P52].*

*"One negative **consequence of poor mental health is lack of confidence.** This would help at least in a small way overcome that" [P75].*

*"**It helps with self-esteem** with me sometimes. It makes **it fun to gain** a goal" [P81].*

*"This would **motivate me** to set goals and make progress" [P335].*

However, sometimes rewards are perceived as negative by users for reasons such as *making them feel down for not earning rewards or pressure to earn the reward.*

*"Some people might **get down on themselves** because they aren't earning enough rewards or any rewards at all." [P66].*

*"I don't like this option because **I would feel pressure to earn rewards.** If I didn't earn rewards, I feel like I would feel worse about myself" [P41].*

Some people stated that gaining good health is their reward.

*"I don't think this will be that effective for me. **The improvement in health is a badge enough**" [P10].*

*"**My reward is my mental health.** not some badge" [P16]*

### 5.5.3.13 Praise

The *praise* feature applauds user for task performance to motivate them towards the desired behavior. The findings revealed that the praise feature is significantly associated with people who are high in extraversion and those high in agreeableness ( $\beta = .20, p < .001$ ) and ( $\beta = .23, p < .001$ ) respectively. However, it is negatively associated with people who are more open to experience as shown in Table 5.4 ( $\beta = -.12, p < .05$ ).

Based on participants' comments, they preferred praise because *it encourages them and boosts their confidence.*

*“These messages would motivate us and encourage us when we complete doing something to take care of mental health” [P419].*

*“Appreciation always boost me and strengthens my mind” [P345].*

However, some people find it de-motivating.

*“This type of feedback would not motivate or encourage me. I usually find it de-motivating” [P32].*

Others such as those open to experience prefer to be appreciated by real people rather than an app.

*“I personally will not feel so much good about this, this won’t change my mood. Appreciation from real people would make us feel good.” [P84].*

#### **5.5.3.14 Encouragement**

*Encouragement* is showing users supportive messages to motivate them to be positive and happy. The results show that people who have a high level extraversion, agreeableness and conscientiousness found encouragement messages to be a significant motivator that could improve their mental health and emotional well-being ( $\beta = .20, p < .001$ ), ( $\beta = .18, p < .001$ ) and ( $\beta = 0.10, p < .001$ ) respectively. However, people who are more open to experience are negatively associated with encouragement ( $\beta = -.20, p < .001$ ).

Some reasons provided by participants in support of the high preference for encouragement include *that it encourages and makes users feel better*.

*“I currently don't have any friends or family. Having something that can encourage and motivate me would help tremendously” [P7].*

*“I appreciate the encouragement. It would make me feel better” [P28].*

Sometimes encouragement is perceived as negative by users for reasons such as *quotes are useless, unhelpful, and distortions from reality*. However, the *content of support messages could impact how people perceived this feature*.



*"Personally, I find these kinds of **quotes useless and unhelpful - they don't provide you with any practical and usable advice**, they just seem an empty and lazy way to try to help someone."* [P46].

*"More often than not, **I find them as distortions from reality**. while they try to make a point, I feel more vulnerable not having the power to make those changes."* [p558].

*"Similar to the tips and suggestions above, this one **would depend entirely on the content**. Some supportive messages might be exactly what I would need to hear at any given moment; others could make me roll my eyes and ignore it; a few could intersect with my personal situation in a way that makes me less likely to use the app in the future."*[P49].

### **5.5.3.15 Distraction**

App with distraction feature provides a variety of distraction tools such as games, puzzles, and funny jokes to entertain users and distract them from their negative mood. The findings reveal that only people who have a high level of extraversion and agreeableness are significantly motivated by the distraction feature,  $\beta = .20, p < .001$ , and  $(\beta = .19, p < .001)$  respectively.

From the participants' comments, I found that participants like a *distraction* because it helps them *combats negative and depressive thoughts and keeps them away from the negative mood*.

*"I love this feature - what a great idea. Distraction is useful to **combat negative self-talk, for one**."* [P31].

*"I like these features as this **keeps me away from my negative mood swings** by engaging myself in these games thereby keeping me away from thoughts that stresses me"* [P410].

However, people who have low preference for the *distraction* feature mentioned that they *need to confront and deal with their issues and not mute them for a short time, as there is no value to that*.

*"People prefer to **solve their issue** not to mute them. It does not have **real value for mental health**"* [P550].

“Games and distractions have nothing to do with mental and emotional health. Distractions **do not make the problem go away; they only mute them for a short time**” [P 9].

“This is just a distraction. It **has no real value to long term mental health.**” [P21].

#### 5.5.4 Summary of Personality and Features of a Persuasive App

Overall, extraversion and agreeableness, emerged as the personality traits that are most responsive to the persuasive features overall, while conscientiousness and openness emerged as the least responsive personality traits. Openness is negatively associated with most off the features while conscientiousness shows no significant association 10 out of the 16 features.

### 5.6 Discussion

In this section, I discuss how my findings can be applied in designing persuasive mental health apps to appeal to both a broader audience and to be tailored to a particular user group depending on their personality.

#### 5.6.1 Designing to Appeal a Wide Range of Audience

The findings reveal that *relaxation audios feature* is perceived as positive by all personalities (extraversion, agreeableness, conscientiousness, neuroticism, and openness). Therefore, **to appeal a wide range of users, mental health apps designers should provide relaxation audios.** This can be implemented in various ways including music, religious worship audio sounds, or sounds of nature.

Moreover, The results show that *relaxation exercises* and *social support* appeal to most personalities. *Relaxation exercises* and *social support* are both perceived as positive by all the personalities (extraversion, agreeableness, openness, and neuroticism) except conscientiousness. However, they do not negatively impact conscientiousness. Therefore, **to design for a wide range of users, mental health apps should provide social support and some relaxation exercises such as breathing exercises, meditation, gratitude, or**

**yoga.** Previous studies show that practicing meditation [90], breathing [45] or gratitude [76] improve people's mental health and emotional well-being.

Similarly, *self-monitoring (tracking)* is perceived as positive by extraversion, agreeableness, and openness and does not negatively impact other personality types. *Self-monitoring* is also one of the highly-rated features overall and one of the most frequently employed features in mental health apps [10]. Therefore, **to appeal to a wide range of people, mental health app designers should implement *Self-monitoring* functionalities that allow people to track their mood** or behaviours to create awareness and opportunities to review trends of their personal data related to mental health.

The results also show that *contact for help* feature which allows user to contact therapists, family, and friends is a significant appeal to extraverted, conscientious, agreeable and neurotic individuals and does not negatively impact people who are more open to the experience. Therefore, to appeal a wide range of people, mental health apps should be designed to allow users to contact therapists, find a counselor or health and wellness society in their area, and call a hotline if they need help.

The *Distraction feature* is also appealing significantly to extraverted and agreeable people and does not negatively impact other personality types. As a result, **mental health apps could implement some distraction tools to distract users from a negative mood.**

### **5.6.2 Designing for Users with a Specific Personality Type**

Designing interventions tailored to individual users or user groups has been recommended in many studies [166], [105]. The results reveal opportunities where personalizing mental health apps via tailoring the features based on users' personalities is highly desired.

For people high in conscientiousness, the results show that they have a strong preference for *relaxation audios, trusted information, contact for help, suggestions, and encouragement*, and thus, they are more likely to be motivated by systems employing these features. However, customization is the only feature that is perceived as negative by people with a high level of conscientiousness. Therefore, **when designing a mental health app to specifically appeal to people high in conscientiousness, designers should employ**

*relaxation audios, trusted information, contact for help, suggestions, and encouragement but should avoid customization.*

The findings also show that neurotic individuals are more likely to be motivated to adopt emotional/ mentally healthy behaviours by apps that provide *relaxation exercises, relaxation audios, contact for help, social support, rewards, and privacy policy*. Therefore, **mental health app designers targeting neurotic individuals should employ these features**. Adapting app features to the needs of neurotic individuals might be especially valuable as many patients with mental disorders score very high on this personality trait, in example those with mood and anxiety disorders [208]. A focus on *relaxation techniques, contact for help, social support, rewards, and privacy policy* could thus help to better engage this highly vulnerable population in the usage of mental health apps. Importantly, symptoms monitoring plays an important role in the clinical management of mental disorders. Ideally, mental health apps should enable passive monitoring of clinical symptoms. Although my study did not reveal a negative impact on a mental health app's perceived persuasiveness among neurotic individuals, app-based active self-monitoring can have a harmful effect in such individuals. In a recent study active self-monitoring via an app was found to increase the likelihood of depressive episodes in patients with mental disorders [65].

The results also show that the improvement in mental health is a reward for some people and the main reason why they would resort to using the app in the first place; however, it does not remove the need for extrinsic rewards such as badges and points, which have been shown to be effective at engaging users [176]. They provide an additional incentive and hence appeal to neurotic people.

The results reveal that there are three personality traits that predict most of the variability in the effectiveness of persuasive features which are extraversion, agreeableness, and openness. While extraversion and agreeableness are significantly and positively associated with most features, openness is negatively associated with most features. This is similar to results found in Orji et al. [169]. **Therefore, to achieve personality-driven personalization, it is necessary that designers at least differentiate participants based on these traits.**

Although there are many ways that mental health apps could be tailored using my results, I have highlighted a few examples here. Table 19 presents the detailed relations between the features and personality traits that could guide design choices for selecting the appropriate features for tailoring persuasive mental health app to various personalities. Researchers can employ the appropriate strategies/features that match individual user’s personality traits by taking into account the users’ explicit responses to personality tests beforehand.

### 5.6.3 Design Guidelines

I propose design guidelines for each feature of persuasive apps concerning mental health issues (Table 5.5) to support designers when designing mental health apps. Each guideline addresses a specific feature in mental health apps that I found during my study.

Table 5.5 Design guidelines for some features of persuasive mental health apps. Each design recommendation is supported by participants' comments or previous studies

Features	Design guidelines
Relaxation audios	<p>Designers can provide options for users to upload their own relaxation audios and adapt already provided audios in the app as necessary. For example, users should be able to delete audios and sort audios based on preferences to make a playlist of favorite audios. This is supported by the following comments:</p> <p><i>“I do use music as a relaxation method so <b>I think this would be great, also if you can make a playlist.</b> Also, just relaxing sounds would be awesome. I love the sound of rain when I am tense” [P52].</i></p> <p><i>“I think that it would be good if <b>you can upload your own audio to play. So, I could keep a catalog of music that has proven to help me reduce stress and anxiety</b>” [P79].</i></p>

Features	Design guidelines
Relaxation exercises	<p>Designers should be careful about the quality of these exercises when designing this feature which could impact how people perceived this feature.</p> <p><i>“It all depends on the quality of this stuff; this could be a helpful tool”</i> [P354].</p> <p>Relaxation exercises should be implemented to be customizable. Users should be able to delete some exercises which do not appeal to them and also organize exercise based on preference.</p> <p><i>“I like that there are different exercises you can do. <b>You can pick what you prefer to do.</b> I like the fact it's not forcing you to choose one.”</i> [P206].</p> <p>Users can also provide feedback on the quality of various exercise recommendation and their effectiveness via short pop-up questions and the system can use the feedback to learn about the user and adapt exercise recommendations to reflect users' preferences, in line with intelligent and adaptive systems.</p> <p>Providing users with instructions on how to do the relaxation exercises would motivate them to use the app.</p> <p><i>“This would be useful. <b>Showing different techniques with instructions would cause me to use it more</b>”</i> [P4].</p>
Social support	<p>When designers employ social support, they should make chatting anonymous to help people to be more open to sharing their issues without fear of stigmatization, which will relieve stress or negative mood. This is in line with previous research that found that one of the weaknesses of social support features is that they have the tendency</p>

Features	Design guidelines
	<p>“to be invasive and jeopardize an individual’s privacy and relationships” [172].</p> <p><i>“Chatting anonymously helps one to be more open and thus relieving stress”</i> [P14].</p> <p>Designers can also offer a 'private mode' where users can express their emotions or feelings without sharing it with the group. They can also share with a virtual avatar or an agent. Research has shown that writing down personal memories and emotions can help in improving mood [211] even without sharing it with anybody.</p>
Self-tracking	<p>Considering that tracking could be tedious and labor-intensive [162] especially when it is manual, designers should design the self-monitoring functionality to be easy to use and present the data in an understandable format using some meaningful visualization. <i>Self-monitoring</i> functionalities could also be automated as much as possible.</p> <p><i>“I think it can be fun to see and helpful but tracking data can <b>bog you down and take time</b>”</i> [P391].</p> <p>Designer should provide a sharing feature to allow users to share the gathered data with the therapist which would motivate users to use the app.</p> <p><i>“It'd also be good to <b>share with a therapist</b> so they could help point out triggers”</i> [P20].</p>
Contact for help	<p><i>Contact for help</i> feature should provide all the necessary information users need to make decisions. For example, information regarding if</p>

Features	Design guidelines
	<p>the therapist or clinic near to them accept their insurance or if they provide free service.</p> <p>It can also allow them to text their therapist or make an appointment without having to make a phone call.</p> <p><i>“It would be also nice to know <b>if these places take your insurance, or are they free services?</b>” [P25].</i></p> <p><i>“It would be even better if it allowed you to <b>make an appointment from the app with your therapist.</b> A lot of times the calling in to make the appointment is harder than it should be” [P344].</i></p> <p>The <i>contact for help</i> feature should be configurable to allow the user to set default contact for help for various emergency situations.</p>
Distraction	<p>Distraction tools such as games could be designed in consultation with mental health therapies to help people to confront and deal with their mental health issues and entertain them at the same time.</p> <p>They also need to be designed to be of good quality and with professional look considering the sensitivity of mental health.</p> <p><i>“I like this a little - if it can <b>stay away from 'being corny' and childish, it would be good</b>” [P377].</i></p>
Trusted information	<p>The information provided should be evidence-based and trusted since most information about mental health on the internet could be conflicting and confusing.</p> <p>The information should be updated periodically to reflect the current state of the art evidence and practices that users can implement in their life as reflected in the comments:</p>



Features	Design guidelines
	<p><i>“Information is always a plus! It would just need <b>to be updated and with new periodic info</b>” [P129].</i></p> <p><i>“It would be more valuable if it <b>provided practices that can be implemented in my own life</b>” [P44].</i></p>
Suggestion	<p><i>Suggestion</i> feature should be tailored/personalized to be relevant to each individual based on the users’ profile.</p> <p><i>"I may like this feature. It would depend on the suggestions, and <b>if those were relevant to me</b>" [P427].</i></p>
Encouragement	<p>Encouragement could be implemented by showing inspirational quotes or supportive messages via the app to motivate users to stay inspired and positive. Chandra et al.[43] found that more than half of the participants reported that they felt supported by the messages that were either inspirational or focused on handling emotions.</p> <p>Designers should allow users to customize and adapt the encouragement messages to suit their personal preferences. It should be possible to turn this feature on/off, control how many times it shows up, and when it should show up.</p> <p><i>“Again, encouragement messages should be a feature that <b>can be turned on or off</b>. You might also consider having the option to show these when the user reaches a certain point in the app use. <b>Maybe show it after 'X' number of hours of use</b>” [P126].</i></p>
Privacy policy and security	<p>To increase the credibility of the mental health app, the designer should provide a passcode feature in mental health apps to secure users' data and reduce their worry about their privacy and make it optional.</p> <p>The privacy policy should be transparent, short, and easy to read.</p>

Features	Design guidelines
	<p><i>“The privacy policy <b>should not be as lengthy and hard to read</b>”</i> [P361].</p>
Reminders	<p>The designer should provide customizable and adaptive reminder to allow users to adapt it to suit their personal preference hence reducing the tendency of overwhelming users with frequent reminders or interrupting their primary tasks with reminders that comes at odd times.</p> <p>It should also be possible to control and adapt the reminder tone/sound, volume, timing, and type whether soundless text pop up, a single beep sound, or flashing/blinking. This will ensure that users can customize to fit their preferences.</p> <p><i>“I like that I am in <b>control of when to be reminded</b>”</i> [P430].</p>
Praise	<p>Designers should allow users to have some control over the praise feature such as turn on/ off the praise feature.</p> <p><i>“I am not opposed to the praise idea in general, I just hope that there would be a setting to <b>allow individuals to turn them off if they want</b>. I could see this working really well for some people while for others (like myself) it would seem cloying and insincere”</i> [P73].</p>

#### 5.6.4 The Relationships between Personality Traits and Persuasive Features Across Various Domains

The results of my comparative analysis of the relation between personality and persuasive features reveal that the effectiveness of persuasive features is domain-dependent and varies depending on the target domain. A persuasive feature that works for one personality type in one domain may not work for another domain. For example, openness is positively associated with self-monitoring in my study (mental health domain) whereas it was

negatively associated with self-monitoring in risky alcohol behavior domain [169] and was not significantly associated with self-monitoring in the transportation habits domain [17] and education domain [50], see Table 5.2. Although research has suggested the possibility of domain-dependency of persuasive features Orji et al. [167], and Kaptein et al. [105], however, my work is the first to establish this with respect to how the effectiveness of persuasive features for various personality type vary across domains by comparing results from seven different domains, see Table 5.6.

Table 5.6 Comparative analysis of the relationship between personality and persuasive features

Persuasive Features	Author	Domain	Personality traits				
			EXT	AGR	CON	NEU	OPE
Self-monitoring	Codish et al. [50]	Education	+				
	Anagnostopoulou et al. [17]	Transportation		+	-	+	
	Orji et al. [169]	Alcohol	+	+	+		-
	Current study	Mental Health	+	+			+
Reward	Codish et al. [50]	Education	+				
	Jia et al. [97]	Healthy Habit				-	
	Halko et al. [80]	Physical Activity	-	-			
	Orji et al. [169]	Alcohol	+	+			-
	Current study	Mental Health	+	+		+	-
Personalization	Anagnostopoulou et al. [17]	Transportation	-	+		+	

Persuasive Features	Author	Domain	Personality traits				
			EXT	AGR	CON	NEU	OPE
	Orji et al. [169]	Alcohol	+	+	+		+
	Current study	Mental Health	+	+			-
Custom ization	Orji et al. [169]	Alcohol	+	+			-
	Current study	Mental Health	+	+	-		-
Competition	Halko et al. [80]	Physical Activity		+	+		+
	Anagnostopoulou et al. [17]	Transportation				+	
	Orji et al. [169]	Alcohol	+	+			-
	Jia et al. [97]	Healthy Habit	+				
	Codish et al. [50]	Education	-				
	Shuttleworth et al. [204]	Physical Activity				+	
Social Comparison	Jia et al. [97]	Healthy Habit	+				
	Codish et al. [50]	Education	-				
	Anagnostopoulou et al. [17]	Transportation		+		+	
	Oyibo et al. [182]	Social Behaviour				-	-
	Orji et al. [169]	Alcohol	+	+			-

Persuasive Features	Author	Domain	Personality traits				
			EXT	AGR	CON	NEU	OPE
	Shuttleworth et al. [204]	Physical Activity				+	
Social Learning	Oyibo et al. [182]	Social Behaviour			-	+	+
	Shuttleworth et al. [204]	Physical Activity					
Praise	Anagnostopoulou et al. [17]	Transportation		+		+	
	Current study	Mental Health	+	+			-
Suggestion	Anagnostopoulou et al. [17]	Transportation		+		+	
	Orji et al. [169]	Alcohol	+		+		
	Current study	Mental Health	+	+	+		-
Cooperation	Halko et al. [80]	Physical Activity			-	-	
	Anagnostopoulou et al. [17]	Transportation		+			
	Orji et al. [169]	Alcohol	+	+			-
Punishment	Halko et al. [80]	Physical Activity	-	-		+	-
	Orji et al. [169]	Alcohol	+	+			-
Simulation	Anagnostopoulou et al. [17]	Transportation		+		+	

Persuasive Features	Author	Domain	Personality traits				
			EXT	AGR	CON	NEU	OPE
	Orji et al. [169]	Alcohol	+	+	+		

## 5.7 Implementing the personality-based model-driven Approach to Tailor the Mental and Emotional Well-being Interventions

To tailor an app using the personality-based model-driven approach, the designers need to follow the following steps.

**First**, designers should identify the personality types to which they intend to tailor the application. This can be done by identifying the personality types represented in the target audience the app intends to be designed for using the validated questionnaire [186]. After completing the questionnaire, the researchers can classify users based on their highest score on the five personality dimensions as done in the previous study [23], with at least 0.5 difference between the highest score in one dimension and the other four dimensions. If there was no difference between the scores in two or more dimensions (having equal score) of a user's personality traits, the personality trait of the user was considered undefined, and the user was moved to the Control group.

**Second**, designers should select the strategy that is significantly positively associated with the personality type they intend to design for. That is a strategy with a positive  $\beta$  value for the selected personality type from the personality model results presented in Table 5.4, indicating that the selected personality trait is motivated by that strategy.

**Third**, designers must avoid any strategy with a significant negative  $\beta$  value which indicates that the selected personality type is demotivated by that strategy. They may also avoid any strategy with no  $\beta$  value, which indicates that the selected personality type is neither motivated nor demotivated by that strategy.

**Finally**, designers can map the selected strategy to the app features that they will implement in the application to motivate behaviour change.

## 5.8 Limitation and Future Work

There are some limitations of this study. First, my study is based on self-reported data about the persuasiveness of various features implementation in a prototype mental health app. The actual persuasiveness of the features might be different when implemented in a mental health app and validated over a long-term. Therefore, I plan to investigate the actual persuasiveness of the features deployed in the mental health app designed following my recommendations in this study. Second, while my study has benefited from the large-scale study of the persuasiveness of the features employed commonly in mental health apps, the results may not generalize to other behavior domains. I show that the effectiveness of the 16 features applied by the prototypes used in the evaluation reported in this study are domain dependent. Finally, I only included participants who self-reported stress, low mood, depression, anxiety, panic attacks, and other forms of mental health-related issues, the results might accordingly not be generalizable to other patient collectives.

This work opens opportunities for advancing research in this area. The research establishes the domain-dependency on the effectiveness of persuasive strategies based on comparative analysis. Future work can control for possible operationalization effect on the effectiveness of the strategies across domain by investigating the effectiveness of similar operationalization across domains. In line with this, research could also investigate whether there is an association between the type of mental issues participants experiences and their preference for certain features. Future research could also examine relationship between personality types and common mental health issues, e.g., very agreeable personalities might tend to be more stressed by trying to appease everyone. Furthermore, research could compare the distribution of personality types in the mental health study sample with the general population, or at least compared to other study samples such as physical activity study which might provide an explanation of the domain dependency on the correlation between personalities and persuasiveness. Finally, future research should examine the domain-dependency of actual persuasiveness of various features implemented in mental health app based on long-term use and evaluation.

## 5.9 Chapter Summary

The aim of this chapter is twofold. Firstly, I explore the relationships between personality and features of a persuasive app that promote mental and emotional well-being. Secondly, I explore possible domain-dependent variability on the relation between personality and persuasive features across seven different domains. Specifically, the study contributes to the HCI and digital health community by advancing the understanding of how an individual's personality traits determine their preference for different persuasive features that are widely used in persuasive mental health apps designed to promote mental health. As a secondary objective, I evaluated the persuasiveness of the features overall and showed their comparative persuasiveness with respect to their ability to promote mental health. The results show that people's personality traits play significant roles in their preference for different persuasive features. Through the study, I uncover the limitations of the one-size-fits-all approach and presented design opportunities for designing mental health apps that appeal both to a wide range of audiences and can also be tailored to a particular personality trait. The results show that extraversion, agreeableness, and openness are the three personality traits that predict most of the variability in the effectiveness of the persuasive features employed in mental health apps. Overall, *relaxation exercise*, *self-monitoring*, emerged as the most feature of a persuasive app while *personalization*, *distractions*, *rewards*, *encouragement*, *credibility (privacy policy)*, *praise*, *customization* emerged as the least features of a persuasive app. Moreover, the results show that conscientious people tend to be motivated by apps that provide *relaxation audios*, *trusted information*, *contact for help*, *suggestions*, and *encouragement*; people who are emotionally unstable are more likely to be motivated by apps that provide *relaxation exercises*, *relaxation audios*, *contact for help*, *social support*, and *privacy policy*; people who are more open to experience tend to be motivated by *relaxation exercises*, *self-monitoring*, *relaxation audios*, and *social support*. Moreover, the study shows that the effectiveness of persuasive features is domain-dependent and varies depending on the target domain.



In this chapter, I developed a personality-based model-driven approach showing the relationship between persuasive strategies/features that emerged from Chapters 2, 3, and 4 and personality traits. Moreover, I presented the findings of possible domain-dependent variability in the relationship between personality and persuasive features across various domains. In the next chapter, I describe the design and implementation of a personality-based model-driven persuasive mental health app informed by design guidelines from this chapter.

## **CHAPTER 6: DESIGN AND IMPLEMENTATION OF PERSONALITY-BASED MODEL-DRIVEN PERSUASIVE MENTAL AND EMOTIONAL WELL-BEING APP**

**Chapter overview:** The previous chapter (Chapter 5) presents a personality-based model-driven approach showing the relationship between persuasive strategies/features that emerged from Chapters 2, 3, and 4 and personality traits. The personality-based model can be used in tailoring persuasive mental and emotional well-being apps to various personality types. In this chapter, I describe the design and implementation of a personality-based model persuasive mental health app informed by design guidelines from the previous chapter. First, I present the three steps of the development process of the persuasive mental and emotional well-being app called “*Be Grateful*”.

- Step 1: The gratitude intervention and the rationale underlying selecting gratitude intervention.
- Step2: Tailoring “*Be Grateful*” app to personality traits.
- Step3: Mapping persuasive strategies to app features.

It is followed by a discussion of deconstructing persuasive strategies/features employed in *Be Grateful* app, including an overview and implementation of *Be Grateful app*, and the type of persuasive strategies employed in each version.

### **6.1 Development Process of Be Grateful App**

In this section, I present a detailed description of the three steps of designing *Be Grateful* app, including what type of persuasive strategies are employed in each version.

#### **6.1.1 Step1: Gratitude Intervention**

To achieve the aim of this thesis, I designed a mental health and emotional well-being app based on gratitude interventions –one of the interventions used in mental health studies to

promote mental health and emotional well-being by helping users to affirm and reflect on the good things that happen in their lives daily – called *Be Grateful*.

#### **6.1.1.1 The rationale for choosing Gratitude Intervention**

I chose gratitude intervention as the focus of our app for the following reasons. First, various systematic reviews demonstrate the potential effectiveness of gratitude interventions in promoting mental health and well-being [60],[217][56]. Second, gratitude activities are simple and easy to understand and carry out [58]. Initial evidence suggested that people enjoyed gratitude interventions, as those that used gratitude interventions had a lower dropout rate than those that used other activities [74]. Third, gratitude activities help people recall deeply meaningful memories, thereby enhancing their mental health. Fourth, according to Seligman et al. [201], gratitude activities may cause a long-term positive change in life satisfaction. Fifth, focusing on the positive things may also encourage a positive mood. The mood congruence cognition bias states that a positive mood reduces the probability of negative—mood incongruent—cognitions [69]. People struggling with mental health issues tend to focus more on the negative things.

In line with this reasoning, previous randomized controlled trials (RCT) have discovered the beneficial effects of gratitude interventions on mental health issues, such as worry [73], rumination [178], depression [122], and anxiety [106]. In addition, numerous studies have examined the effect of positive psychology interventions on various aspects of mental health, including happiness, engagement, positive emotions, and others [201], [203]. Moreover, two meta-analyses reviews show the possible effect of positive psychology interventions on promoting mental well-being [206],[35]. However, White et al. [225] conducted a meta-analysis and showed that the impact of positive psychology interventions on well-being is overestimated. Nevertheless, among all three meta-analysis studies, gratitude interventions are perceived as one of the most effective positive psychology interventions. In addition, a recent meta-analysis of gratitude interventions showed the effect of gratitude interventions on promoting mental well-being [58]. Consequently, we designed *Be Grateful* app based on gratitude interventions.

### 6.1.2 Step2: Tailoring Be Grateful App to Personality Traits

A tailored persuasive app is an expression used to describe persuasive apps tailored to individual personality types using their best strategies. In contrast, a contra-tailored persuasive app is used to describe persuasive apps designed using strategies that have no significant effect on users' personality types or are perceived as negative by the personality type [33]. Moreover, a Mixed-tailored app is a term used to describe persuasive apps designed using mixed strategies (half of the strategies are perceived as negative by the personality type or have no significant effect on the personality type. The other half of the strategies are perceived as positive by the personality type). To achieve the goal of this thesis, I designed three versions of *Be Grateful* app.

**First version:** A single-strategy version contains one strategy tailored to highly extraverted people (**tailored single-strategy**). It's worth noting that this version is also a contra-tailored to people who are highly open to a new experience.

**Second version:** A multi-strategy version contains two strategies that are tailored to highly extraverted people (**tailored multi-strategy**).

**Third version:** a Mixed-strategy version has four strategies. Two strategies are perceived as positive by people who are highly open to a new experience. The other two are perceived as negative by people who are highly open to a new experience (**mixed-strategy**).

I adapted only the persuasive strategies employed in the three versions of the gratitude interventions while keeping other design elements the same. Thus, the users' experience of the app is the same – only the number of persuasive strategies changes.

In the following subsection, I briefly describe the rationale for choosing these personality types and the strategies employed in the persuasive app design. It is followed by detailed descriptions of Be Grateful app.

#### 6.1.2.1 Rationale for Choosing Personality Traits and Persuasive Features

Considering that it is not feasible to design a tailored persuasive mental health app for all five personality traits using all the strategies highlighted by the personality-based model,

I decided to design two out of the five personality traits – Extraversion and Openness. The main reason for choosing these two personality traits is that the previous study has shown that people with higher levels of extraversion and openness benefitted more from the gratitude intervention. There were no significant effects on the other three personality traits [202].

Table 6.1 Standardized path coefficients ( $\beta$ ) for Extraversion and Openness. Distinct coefficients are highlighted with orange. All displayed coefficients are significant at  $p < .05$ , whereas ‘-’ represents non-significant coefficients – Taken from the mode

<b>strategies</b>	<b>Extraversion</b>	<b>Openness</b>
Relaxation Exercise	.15	.16
Self-monitoring	.14	.13
Reminder	.14	-.10
Relaxation Audio	.10	.17
Verifiability	.10	-.24
Contact for Help	.11	-
Social Support	.10	.11
Security feature	.16	-.21
Suggestion	.20	-.19
Personalization	.13	-.15
Distraction	.20	-
Rewards	.18	-.10
Encouragement	.15	-.19
Credibility	.19	-.16
Praise	.19	-.12

strategies	Extraversion	Openness
Customization	.15	-.14

The following considerations guided the choice of persuasive strategies in each version.

**Tailored single-strategy version:** The chosen strategy in this version should have opposite effects on the two personality types – Extraversion and Openness – concerning their perceived persuasiveness. This allows to compare the influence of persuasive mental and emotional well-being apps designed using the strategy perceived as positive (tailored) by extraverted people versus the strategy perceived as negative (contra-tailored) by people who are highly open to a new experience. As a result, I decided to tailor the persuasive mental and emotional well-being app using suggestions&encouragement features together (Table 6.1). I have combined the suggestion and encouragement strategies into a single strategy because I need to encourage people to perform the suggested acts of kindness. From the model, suggestions&encouragement emerged as the best strategy for extraverted people, and it is also one of the worst strategies that may have a negative influence on people who are highly open to a new experience.

**Tailored multi-strategy version:** The choice of the two strategies in this version should positively influence the extraverted people (tailored). One of these two strategies should be the same strategy employed in the first version. As a result, I decided to tailor the persuasive mental and emotional well-being app using the suggestions&encouragement employed in the first version and social support as the second strategy in this version (Table 6.1). This allows us to compare the influence of persuasive apps designed using a single strategy and a multi-strategy tailored to highly extraverted people.

**Mixed-strategy version:** The chosen strategies in this version should affect one personality type –Openness – with respect to their perceived persuasiveness. This allows us to examine the effectiveness of persuasive apps designed using mixed strategies (two strategies are perceived as positive, and the other two strategies are perceived as negative by one personality type). As a result, I decided to design a mixed-strategy persuasive mental and emotional well-being version using the suggestions&encouragement and

reminder strategies as they are perceived as negative and social support and self-monitoring strategies as they are perceived as positive by people who are highly open to experience (Table 6.1).

Consequently, for the personality-based model-driven persuasive app “Be Grateful”, I designed three versions. The tailored single-strategy version was tailored to extraverted people using single strategy (this version is a contra-tailored for Openness people) and the tailored multi-strategy version was tailored to extraverted people using two strategies while the mixed-strategy (two positive strategies and two negative strategies) was designed for Openness people.

### 6.1.3 Step3: Mapping Persuasive Strategies to App Features

Mapping the persuasive strategies to app features can help bridge the gap between the mental and emotional well-being app designers and persuasive technology designers.

Based on our comprehensive literature review (presented in Chapter 2) and systematic review of mental health apps available in both the App Store and Google Play (presented in Chapter 3), I was able to use some of the successful implementations of the persuasive strategies (suggestion&encouragement, social support, self-monitoring, reminder) as tangible design components employed in the app. Table 6.2 shows the common implementation of these strategies derived from the literature review in Chapter 2 and apps’ review in Chapter 3.

Table 6.2 The common implementations of (Suggestion&Encouragement, Social Support, Self-monitoring, Reminder) strategies from Chapter 2 and 3

Strategies	The common Implementation of strategies from Chapters (2&3)
Suggestion&Encouragement strategy	Suggestion&Encouragement strategy can appear as a pop-up message on the phone to suggest doing a task or an activity [37] with showing a supportive message, or positive motivational quotes.

Strategies	The common Implementation of strategies from Chapters (2&3)
Social Support	Social Support was implemented as a means of social interaction through community forums. The forum allows no threads to make it simple for the users. Users can choose a nickname to use the forum, and posts are ordered from most recent to least recent [70]. Users can also respond anonymously to another user's content by "like" and showing how many users liked it [62].
Self monitoring	Self-monitoring was implemented as being able to track the symptoms or mood by using a horizontal slide scale, and the collected information is visualized in a graphical format alongside contextual information [82].
Reminder	Reminder was designed as auditory signals and visual notifications that appear on the mobile screen [100].

I developed the prototype of *Be Grateful* app representing the four persuasive features using Balsamiq [87]. I presented it to the Persuasive Computing Lab, consisting of 20 persuasive technology researchers, to get feedback and insights on the proposed design. I considered all the following suggestions from the group members and improved the design to increase the overall persuasiveness.

- 1- Changing the slider rating of the mood to face slider rating.
- 2- Allowing users to attach a picture with their gratitude.
- 3- Reminding users of their previous gratitude as positive quotes related to their gratitude.
- 4- Allowing users to secure their gratitude journal using a password.



- 5- Asking users if they would like to share their gratitude in the social community.
- 6- Adding some contextual data that represent the mood on the visualization.

## **6.2 Deconstructing Persuasive Features Employed in Be Grateful App**

In this section, I present a detailed description of *Be Grateful* app, including implementation of *Be Grateful* App, the three versions of the app, what type of persuasive strategies are employed in each version, and user interactions.

### **6.2.1 Overview and Implementation of Be Grateful app**

The app “*Be Grateful*” is a gratitude intervention that promotes mental health and emotional well-being by helping users to affirm and reflect on the good things that happen in their lives daily.

*Be Grateful* is a cross-platform app that runs on both Android and iOS mobiles. It was developed using Flutter as a development platform. Flutter is an open-source, multi-platform mobile SDK that can be used to build an app on both iOS and Android, using a single codebase, and uses "Dart" as the programming language. I used Android Studio with the Flutter plugin installed. I chose Flutter as a development platform to design *Be Grateful* app to be accessible for both Android users and iOS users as I need to examine the persuasive mental health app in a large participant sample and diverse audience. The data the app collects are stored and managed securely through the MySQL database in Web Hosting Canada (WHC).

I adapted only the persuasive strategies employed in the three versions of the gratitude interventions while keeping other design elements the same. Thus, the app's user experience is the same – only the persuasive strategies change.

### **6.2.2 The Common Features in All Versions of Be Grateful App**

All three versions were built using a single codebase, and based on the version, the app shows the strategies related to the specific version. All versions of *Be Grateful* app encourage users to express and reflect on what they are grateful for, tracking the good things that happen in their lives.

The app begins with an introductory page explaining the primary goal of the app (Figure 6.1.a); this is followed by the screen that allows users to write what they are grateful for each day (gratitude) and attach or capture a picture with their gratitude as shown in Figure 6.1.b. The gratitude entries are displayed on the journal screen (Figure 6.1.c). In the setting, users can change their email, nickname and password. They can also activate the password lock, contact the researcher for any issue, and see how the app works (Figure 6.1.d). The app also reminds users of their previous gratitude by showing them positive quotes related to their gratitude for the previous day (Figure 6.1.e). For example, if a user was grateful for having a family the previous day, the app shows a positive quote about the family the next day. If the user's gratitude does not match the positive quote database, the app shows what users were grateful for from the previous day.

### **6.2.3 The Features in Each Version of Be Grateful App**

As shown in Table 6.3:

The tailored single-strategy version has one strategy: a suggestion&encouragement strategy tailored to highly extroverted people and contra-tailored to people who are highly open to a new experience.

The tailored multi-strategy version has two strategies: suggestion&encouragement strategy and social support strategy tailored to highly extroverted people.

The mixed-strategy version has four strategies: a suggestion&encouragement strategy and reminder strategy (perceived as negative strategies by people who are highly open to a new experience), social support strategy and self-monitoring strategy (perceived as positive strategies by people who are highly open to a new experience).

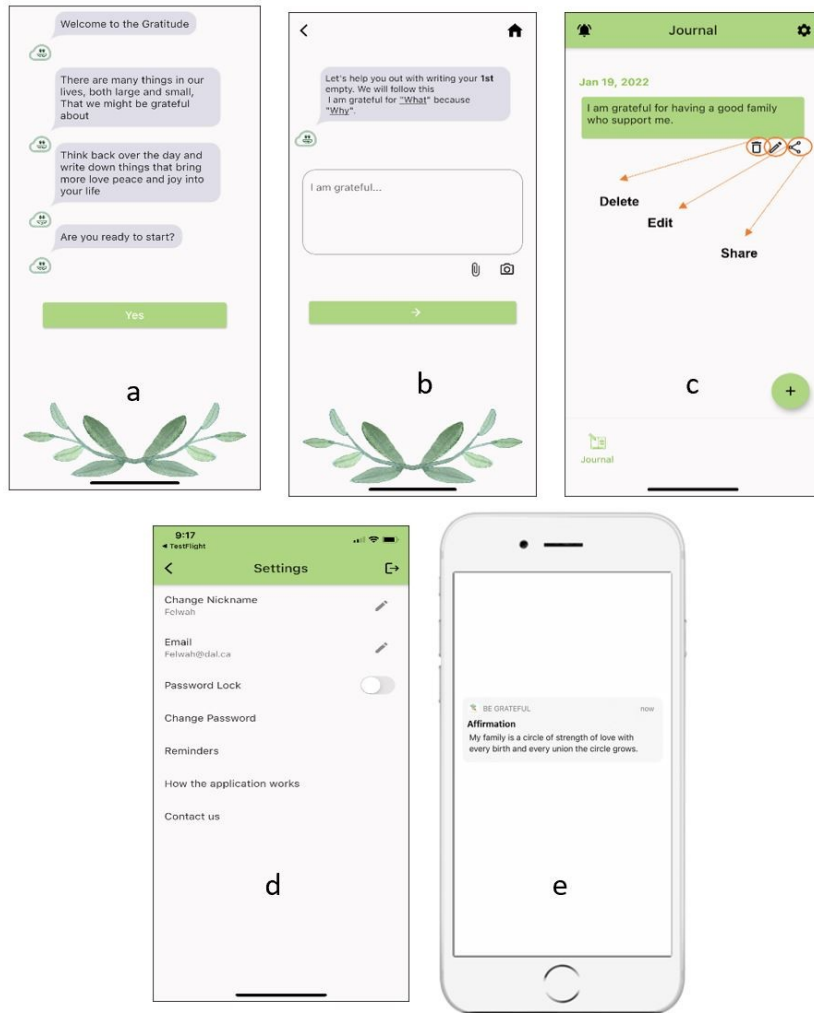


Figure 6.1 Be Grateful. a) The welcome screen explains the app's primary goal, b) The screen allows users to write gratitude, c) The journal shows users gratitude entries, d) Setting screen, e) Affirmation notification shows positive quote related to previous gratitude.

Table 6.3 The persuasive strategies in each version of Be Grateful app and how it perceived by personality types. (Yes) indicates availability of the strategy in the version and (No) indicates unavailability of the strategy in the version

Be Grateful app versions	Discription of each version	Persuasive Strategies in each version			
		Suggestion & encouragement	Social Support	Self-monitoring	Reminder
Tailored single-strategy	It has a single strategy perceived as positive by extraverted people and negative by openness people	Yes (+)	No	No	No
Tailored multi-strategy	It has multiple (Two) strategies perceived as positive by extraverted people	Yes (+)	Yes (+)	No	No
Mixed-strategy	It has mixed strategies (two perceived as positive and two perceived as negative by openness people)	Yes (-)	Yes (+)	Yes (+)	Yes (-)

#### 6.2.4 The implementation of Persuasive strategies of Be Grateful App

This section shows how I implemented all persuasive strategies included in *Be Grateful* app based on the common implementation, as shown in Table 6.2.

#### **6.2.4.1 Suggestion&encouragement Strategy**

I implemented the suggestion&encouragement strategy in the form of an encouragement statement that motivates users to do an act of kindness and appears in the notifications of Be Grateful app. Figure 6.2 shows an example of the act of kindness suggested to the user with an encouragement statement to do it.

#### **6.2.4.2 Reminder Strategy**

The reminder strategy is implemented as a flexible reminder that remind users to enter their gratitude. The reminder strategy is intuitive and easy and can be reached by clicking on the bell icon on the main screen of Be Grateful App. Once permission is granted, a daily reminder can be set as well as the date and the time to be reminded (Figure 6.3.a). Reminder was designed as auditory signals and visual notifications that appear on the mobile screen (Figure 6.3.b).

#### **6.2.4.3 Social Support Strategy**

I implemented social support as a means of social interaction in form of community forums. Users can also respond anonymously to another user's content by "liking" and showing how many users liked it. The posts in the forum are ordered from most recent to least recent. Figure 6.4 shows a social community screen.

#### **6.2.4.4 Self-monitoring Strategy**

Self-monitoring was implemented to track the mood after expressing gratitude using a horizontal faces slider rating. The collected feeling pattern is visualized in a graphical format as a weekly and monthly column chart (Figure 6.5).

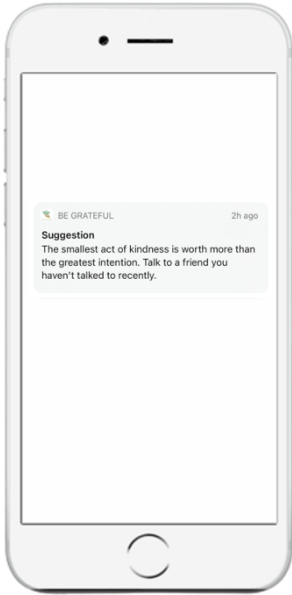


Figure 6.2 suggestion&encourgment strategy

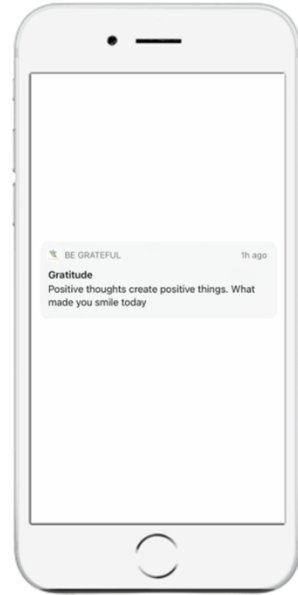
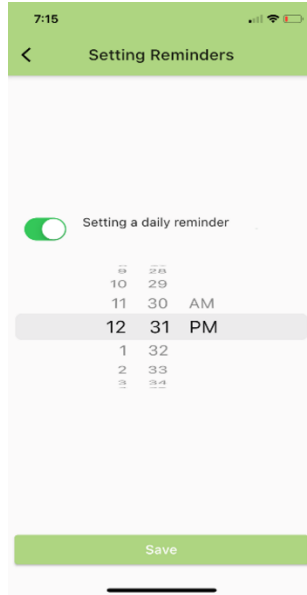


Figure 6.3 Reminder strategy (a and b) in order from left to right

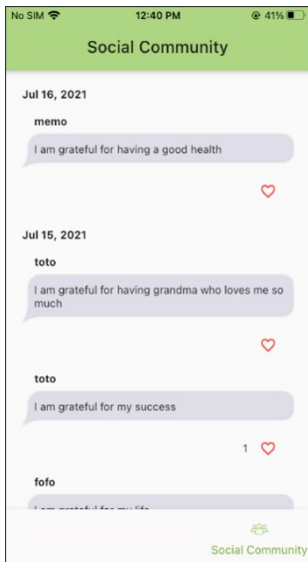


Figure 6.4 social support strategy

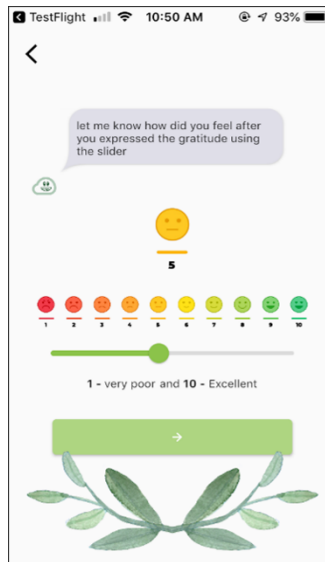


Figure 6.5 Self-monitoring strategy (a, and b) in order from left to right



This chapter described the design and implementation of a personality-based model persuasive mental health app called “*Be Grateful*” which was informed by the personality-based model described in Chapter 5. Improving the usability of persuasive strategies is crucial to the effectiveness of gratitude apps. The more usable an app is, the more likely an individual keeps using the intervention. Therefore, the next chapter describes the usability testing study of the designed app and how the result was used to refine the app and arrive at the final design.

## CHAPTER 7: USABILITY TESTING OF BE GRATEFUL

### APP AND THE FINAL DESIGN

**Chapter Overview:** The previous chapter (Chapter 6) describes the initial design and implementation of *Be Grateful* app for all three versions, which were informed by the personality-based model described in Chapter 5. This chapter describes the usability testing study of the designed app <sup>6</sup> and how the result was used to refine the app and arrive at the final design.

#### 7.1 The Objective of This Chapter

The goal of using such design is to increase the depth of evaluation and to improve the reliability and validity of our results [78]. Specifically, I evaluated the usability of *Be Grateful* app using a qualitative interview along with quantitative study.

#### 7.2 Study Design

Usability is one of the key factors in the successful implementation of mobile health (mHealth) apps, as it is for other apps. There are several methods for conducting usability testing of mHealth apps. According to a review by Maramba et al. [42], six major usability testing approaches are followed in mHealth literature: questionnaires, task completion, ‘Think-Aloud’, interviews, heuristic testing, and focus groups. The study also found that most studies use one or two testing methods, and questionnaires are the most commonly used usability testing methods in health-related studies [42]. Thus, I employed a mixed-method design (qualitative and quantitative data), namely, the System Usability Scale and semi-structured interviews to evaluate the usability of *Be Grateful* app.

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<sup>6</sup> Originally published in Alqahtani, F., Alslaity, A., & Orji, R. (2022). Usability Testing of a Gratitude Application for Promoting Mental Well-Being. In International Conference on Human-Computer Interaction (pp. 296-312). Springer, Cham.



### 7.2.1 Participants

I recruited 14 participants (age range of most of our participants (93%) was 18-34 years; eight males and six females) who have experienced mental health issues such as stress, low mood, negative thought and mood, and so on based on self-diagnosis. A total of 4 participants have used a mental health app to promote their mental health, and the most mental health issue that participants had experienced was stress. Table 7.1 shows participants' demographics for the study.

Table 7.1 participants' demographics information

<b>Demographics</b>	<b>Percentage</b>
Gender	Male (57%), Female (43%)
Age	18-24 (50%), 25-34 (43%), and 35-44 (7%)
Education	Bachelor's degree (71%), Master's degree (21%) and High School or equivalent (7%)
Mental health issues	Stress (23%), Worry (17%), Negative feelings (13%), Negative thoughts (19%), Low moods (15%), Fear (8%), and Anxiety (6%).

### 7.2.2 Procedure

I evaluated the usability of Be Grateful app using a qualitative interview along with quantitative study.

The study evolved through three phases: First, I obtained participant consent and demographics before using the app. Second, participants who signed the consent form were given the Be Grateful app. These users were asked to use the app for ten days. During these ten days, I asked participants to express their gratitude daily using the app. At the end of the 10th day, I asked participants to fill out the System Usability Scale (SUS) scale that has been used widely for usability testing in eHealth studies [140] and is found to be

a reliable and valid tool for evaluating the usability of mobile apps [117]. It consists of a 10-item questionnaire with a 5-point Likert-type scale ranging from 1= strongly disagree to 5= strongly agree. Finally, I met the participants for an online interview. Qualitative interviews allow for a more comprehensive understanding of participants' experience and encourage participants to think about ways to improve usability, identify usability issues and obtain further information about what participants like and dislike about the app. The interviews were audio-recorded and transcribed for coding.

### **7.2.3 Data Collection and Analysis**

I used descriptive statistics to summarize the quantitative data from the SUS. The data collected through the online interviews were analyzed using thematic analysis. The thematic analysis allows us to analyze the data in a systematic manner to uncover patterns in the text while considering the context of what participants said which help to inform our interpretation of the data more accurately. A thematic analysis was undertaken as outlined by Braun and Clarke [19]: (1) becoming familiar with the data, (2) generating initial codes, (3) searching for themes, (4) defining themes, (5) iteratively reviewing themes, and (6) writing up the results.

Specifically, two researchers individually coded sample transcripts by reading and re-reading the sample transcripts (iteratively) to identify codes using open coding. The two researchers then met to compare the initial codes, which were expanded, developed, and modified as new codes emerged. Any discrepancies between the two researchers were resolved through discussion. The initial codes were used to code the remaining transcripts, and they were extended as necessary. For creating the themes, the two researchers systematically refined the themes by going back and forth between the data and the coding framework. I provide quotes as specific examples from each theme within the results section. To preserve participants' privacy and anonymize the responses, I identify participants by anonymized IDs (e.g., P1, P2, etc.).

## 7.3 Results

### 7.3.1 Quantitative Results

Overall, SUS scores and item means were reported to provide a complete view of the usability of the gratitude app. The score was calculated using the method described in [13]. The mean SUS score was 83.93, which indicates that the usability of the app was above average [13].and the app has higher usability than 73% of all products tested [53].

### 7.3.2 Qualitative Results

After setting the initial codes, revisiting them, and updating when required, our thematic analysis resulted in defining three themes: functionality of gratitude app, the user interface of gratitude app, and design of gratitude app. The following subsections define each one of these themes and provide sample quotes as examples.

#### 7.3.2.1 Functionality of the Gratitude App

This theme reflected how the participants appreciated the simple and straightforward functionality of the gratitude app. Based on our analysis, all participants highlighted simplicity and ease of use as one of the desirable characteristics of the gratitude app that they liked.

For example, *“It’s really simple. So, this is the beauty of the app, I like it. It is very simple and easy to use”* [P1].

Moreover, participants mentioned that process of entering gratitude in the app is straightforward and does not require too much effort to be used or understood.

For example, *“It is very simple. You don't have to think a lot or what you need to do. So, it is something very straightforward. You just open the app and it's right there to write what you're grateful for and it gives you a template. So, I love that because I didn't have to worry about like, okay, this is another task that I need to think about, and to put a lot of energy into that because I already have a lot of other stress and things in my life. So that's why I liked it”* [P3].

### 7.3.2.2 User Interface of the Gratitude App

This theme reflects users' opinions about the overall appearance of the app design. Most participants liked the well-structured and visually appealing UI of the app.

For example, *“I really enjoyed using the app because the look of the app was really interesting to me and I love the green aesthetic of the app and the design overall”* [P10].

*“I really like how it looks. It's very visually pleasing. It's a calming theme. The color scheme is really nice. Everything laid out very well”* [P2].

### 7.3.2.3 Design of Gratitude App

This theme reflects the most common issues and points mentioned by participants regarding the usability of the app liked features and requested features to improve the usability of the app. It is worth noting that the gratitude app consists of five features: general design of gratitude intervention, self-monitoring and visualization of the feeling, social community in the app, reminder notification, and suggestion notification. In the following subsections, I provide users' feedback regarding the design of each feature.

**General design of Gratitude intervention:** Entering what participants are grateful for each day helped most participants improve their mood by helping them remember and reflect on good things that happened to them throughout the day. However, 4 out of 14 participants felt that writing gratitude each day is not for them because they felt that expressing gratitude is a personal feeling and is not for recording in an app. Below are some sample comments from participants:

*“For somebody like me who is not used to logging their own gratitude using an app. So, it may not be an everyday thing for me”* [P5].

*“It might not be something I would use myself, I wouldn't be that much willing to have an app close to me. So, like expressing gratitude, these are sort of somewhat personal feelings or expressions that I would keep to myself”* [P2].

Participants liked attaching a picture with their gratitude and felt this made the journaling gratitude more personal for them. Few participants liked the affirmation that reminds

participants of their previous gratitude entry by showing them a positive quote related to their gratitude or their exact gratitude. Below are some sample related comments from participants:

*“I like the feature that **allows me to add a photo to my gratitude. So, it gives more sense of personality for me**” [P1].*

*“It's good to have something to **remind you about good things that have happened to you**” [P10].*

However, most of the participants were confused regarding using “affirmation” as the title for the notification, and they did not know what it means. Thus, some participants requested that I change the title to be more understandable for the general population.

For example, *“I had some **confusion regarding what's the meaning of affirmation**” [P6].*

*“It's **confusing when you look at affirmation... Break it down to something that can be understood by the general people**” [P4].*

Moreover, two participants requested including gamification techniques to increase users' engagement in the app.

For example, *“If maybe there are certain things in the app that can keep me engaged, maybe something that like **introducing things around gamification and the app that can probably nudge people each day to do something for a reward**” [P5].*

**Self-Monitoring and Visualizing Feeling:** Most participants appreciated using the faces slider rating to rate their feelings. They highlighted that using faces slider rating made it easy to rate their feeling after expressing gratitude. Below are some sample related comments from participants.

*“I like the monitoring most; I like the **faces slider because it was easy to understand and to tell how I was feeling because of the colors and also the numbers and the faces. I think it was pretty easy**” [P3].*

Some participants requested to track their feeling before expressing gratitude and after to see how their feelings change.

For example, *“I would like to suggest that the app asks me my mood first, like, you know, ask me to rate my mood from 1 to 10”* [P6].

*“It would be nice to have a pre mood’s assessment”* [P7].

For visualizing the feelings, even though some participants liked the visualizing section because it helped them see how their feelings improved over the ten days, most participants requested some improvement in the visualization to be more usable. Participants were confused regarding the month view and week view and preferred showing the whole month in one screen for the month view instead of tapping to see the rest of the days.

For example, *“For the month view in the visualization, you can compress the chart to show the entire days of the month in one screen”* [P5].

Participants also requested that I show the name of the month on the top of the visualization. So, when users move from month to month, they do not need to look at the x-axis to know which month they were in. They also requested to show the faces instead of a number in the graph because they might forget what the number means.

For example, *“You know when you have the front and the back arrow so you can move from one month to the other month. I think it's good to have the months that you are dealing with as a title there”* [P5].

*“I suggested that you use the faces in the graph, just to give another option of what the numbers mean”* [P3].

Some participants mentioned that using a bar chart for visualizing feelings would not be effective. Instead, they prefer using another visualization such as calendar visualization and showing what participants were grateful for by clicking on the faces in the calendar.

For example, *“You may keep the analytics screen as a Month view only, showing a calendar of an entire month and an emoji on each day depending on the mood of the user”* [P6].

**Social Community in the App:** Based on our thematic analysis, most participants appreciated the social community feature because it encouraged them to share their

gratitude and made them think more about good things in their lives which they took for granted while reading what others are grateful for.

For example, “***In the community feature, I got an opportunity to think of others and what they are grateful for which made me think more about the good things in my life***” [P6].

“***I like the fact that it's showing me what people share that they were grateful for. I know when I read that, sometimes I take for granted and I see that people are grateful for it***” [P13].

Another feature that the participants appreciate is the anonymity of the social community.

For example, “***The thing I like very much is that there is no way to know who likes your gratitude on social community***” [P1].

However, one participant felt that seeing how many likes they got added a cognitive load in their mind. Also, few participants felt that gratitude is something personal, so they hesitated or did not prefer to share it with the social community in the app. As a result, they appreciated how the app gave them an option to share their gratitude in the app.

For example, “***I found that sharing in social community added a cognitive load in my mind because I started to measure my gratitude by the number of likes that I would get***” [P10].

“***For somebody like me. I just didn't feel like posting my gratitude out there. I mean, I liked it, but I see that something personal in a way***” [P14].

For example, “***There are other things which are personal to me that I did not share with the community***” [P4].

Moreover, participants suggested some improvements in the social community, such as the ability to interact with other users, inviting people to the social community, and adding more reactions.

For example, “***There should be a way of interacting aside from just liking in social community***” [P11].

*“Now, you have only heart reaction in the social community, but you can add more reaction such as a flower or a green leaf or a smile” [P10].*

**Reminder Notification:** On our app, I have a reminder to remind users to enter their gratitude, and this reminder includes encouragement statements to motivate users to enter their gratitude. Most participants liked how the app encourages and reminds them at the same time to enter their gratitude. However, they requested that the app keep reminding them to enter their gratitude if they missed it before the end of the day.

For example:” *if I have not logged by 7 pm, for example, **there should be a different or another notification that would tell me to log***” [P5].

**Suggestion notification:** The app notifies users with some suggestions that randomly suggest performing some act of kindness. Some participants liked the variety and the content of the suggestion and how they were easy to do. Other participants requested some improvement by personalizing the suggestions and receiving the suggestion based on user’s mood or when they wanted.

For example, *“There were some **useful notifications. I remember the one, which encourages me to do some act of kindness using a motivation quote. I really like this suggestion**”* [P2].

*“You can improve the app by **providing personalized recommendations**, like for example, using what I type in and also what the others typed similar to what I've typed to give a personalized recommendation”* [P4].

## **7.4 Discussion**

Evidence-based interventions, such as mHealth apps, to promote mental wellbeing, are important to enhance the quality of life. Although mHealth offers a promising way to deliver the interventions, there are still high levels of drop-outs/attrition for this form of intervention [195][21]. One potential contributing reason for abandoning mental health apps is poor usability, particularly when the app is designed based on a self-help way [12].

In this study, I conducted usability testing of a mental health app called Be Grateful aiming to promote mental wellbeing by focusing on good and positive things in people's



lives by expressing gratitude. Be Grateful app designed using persuasive design strategies to improve user experience. This study aimed to identify usability concerns and improve the current design of the “Be Grateful” app. Moreover, perceived usability data were obtained from end-users to evaluate preferences and perceptions of the app.

#### **7.4.1 Principal Findings and Design Implications**

Overall, participants gave the Be Grateful app high scores on validated usability scales. They also provided many positive comments on the app design. I found that users perceived an easy-to-use interface and straightforward functionality as the most important usability features in the app. I also found that the clear and visually appealing design of the user interface was integral to the level of usability. The findings of this study are consistent with previous research, which found that ease of use and simplicity of the app were the most important characteristics of mental health apps that were highlighted by users [3]. Moreover, a visual appeal was among the most important features of a mental health app that participants considered in previous studies [32],[5]. **Therefore, if the mental health app is difficult to use, users may cease to use the app even if it is useful. Users do not like using an app that may add to their stress.**

Most participants liked practicing gratitude and the way the app reminded them of their previous gratitude. They also felt that their mental well-being improved. However, some people think recording their gratitude in the app makes it no longer personal or private. This concern probably has to do with privacy issues, especially for people who are privacy-conscious. Although I provided social features that allow users to share their daily gratitude if they would like to, it seems that some users still don't feel free to share it with the app. This probably has to do with the sensitive nature of mental health-related topics. Hence, **designers of mHealth apps, especially those focused on mental-health-related issues, should pay serious attention to ensuring and assuring users of their privacy. They should also use social features with great caution as they may trigger some sense of insecurity and lack of privacy even when it's optional.** This is probably because most commercially available mental health apps designers cannot be trusted with respect to the

way they handle users' data and information. Research has shown they often do not have a clear privacy policy, and even when they do, they do not keep to it [33].

One of the features in the app design was to leverage self-monitoring of mood after expressing gratitude as a way to show participants their mood over the days of practicing gratitude. Even though participants reported that the mood monitoring scale and associated graphical feedback increased self-awareness of how their mood improved over time in relation to practicing gratitude which is also consistent with prior research in which the use of self-monitoring of mood increased self-awareness of users, **the design of the graphical feedback should be clear and provide information that makes it easy to understand**. In addition, although self-monitoring has been successfully deployed in various mHealth apps, individuals' responses to self-monitoring vary [12]. Thus, **self-monitoring needs to be personalized and individualized to improve users' adherence**.

In regard to social and community features, participants appreciated the app for giving them an option to share their gratitude in the social community. Also, my findings show that allowing people the opportunity to read what others are grateful for increases their awareness of the good things in their lives, which inevitably makes them happy and grateful. Previous research found that there is significant evidence that sharing positive experiences is associated with increased daily positive emotion and subject wellbeing [20], life satisfaction and happiness [23], and resilience [7]. Hence, sharing gratitude is a good way to share happiness. **I, therefore, suggest that app designers provide an opportunity to view other people's gratitude**.

However, as mentioned above, some users have concerns about sharing their gratitude, which is probably due to privacy issues and the possibility of sharing gratitude to threaten privacy. **Therefore, designers should plan to preserve privacy while inculcating sharing features. For instance, designers could give users control over the app features and functionality by giving users agency in the app to decide what they want or not; designers may also implement mechanisms that let users anonymize their identity or use nicknames**. Nevertheless, social activities do not come without negative impacts. Using social features such as (likes and comments) may introduce some negative

comparisons and cause mental stress to the users. **Hence, designing social-related features should be done with caution.**

One of the recommendations that participants also suggested to include rewards to motivate users and increase their engagement. Although only a few mental health apps employed rewards in their design [3], users with mental health issues might benefit from rewards to motivate them to keep using the app. Moreover, according to Orji et al. [38], performing health behaviours is often difficult because of a lack of immediate tangible benefits. Offering intermediate rewards such as points may help to engage the users while they await the intrinsic reward. **Therefore, designers of mental health app could employ rewards to motivate users and enhance their engagement in the app.**

Although participants liked the variety of the suggestions and how they were easy to do, few participants recommended personalizing the suggestions and showing them based on users' moods. This is consistent with previous research, which found that lack of personalization might impact the system's overall usability [3]. **Therefore, I recommend designers to model the app's users and personalize some of the app's functionality accordingly.** Personalization can enhance the overall usability and ensure a personalized experience for each user.

Improving the usability of persuasive strategies is crucial to the effectiveness of gratitude apps, as other mHealth apps. The more usable an app is, the more likely an individual keeps using the intervention. Indeed, higher engagement through logins and repeated use is associated with better participant health outcomes [38].

## **7.5 Final Design of Be Grateful App**

In this section, I present the final design of Be Grateful app after considering participants' feedback.

### **7.5.1 How the Final Version of Be Grateful Works.**

Here, I explain how the app works for the final version that includes all features. However, Table 7.2 shows each version and what features each has.

When a user downloads and installs the app, a demo shows up a series of screens guiding users through the app's interface and functions (Figure 7.1). Then the app asks the user to create an account, as shown in Figure 7.2. The app introduces users to gratitude interventions by explaining what they need to do (Figure 7.3). It asks them to rate their mood of the day before expressing gratitude using the faces slider rating (Figure 7.4). The app then guides users to write what they are grateful for and if they would like to take a picture with gratitude (Figure 7.5). After that, the app asks users if they would like to share their gratitude in the social community in the app (Figure 7.6) and asks them to rate their mood after expressing gratitude using the faces slider rating (Figure 7.7).

The app contains four main screens:

- A Journal screen shows users' gratitude entries, and pictures users attach or capture (Figure 7.8). Also, in the Journal screen, users can delete, edit their gratitude and share it with other social media. The app also reminds users of their previous gratitude by showing them positive quotes related to their gratitude for the previous day. For example, if a user was grateful for having a family the previous day, the app shows a positive quote about the family the next day (Figure 7.9)
- The Gratitude Lilies screen presents the gratitude entries as water lilies flowers (Figure 7.10). The user gains a water lily flower each time they enter their gratitude, and the color of the lily flower changes depending on what the user is grateful for – the category of gratitude. In general, there are twelve main categories of gratitude, each of which corresponds to a distinct color of the lily flower. For example, if a user is grateful for people, they gain a pink lily flower and for nature, they gain a yellow lily flower. Again, each water lily flower houses/stores the corresponding gratitude for the day and users can easily retrieve their gratitude at any time by clicking each water lily flower, gratitude shows up (see Figure 7.11).
- A Mood Summary screen enables users to see their feeling patterns before and after expressing gratitude as faces in calendar format (Figure 7.12). Each face houses/stores the corresponding gratitude for the day and users can easily retrieve

their gratitude at any time by clicking each face in calendar, gratitude shows up (Figure 7.13).

- In Social Community screen users can read, like, comment on others' gratitude and share their gratitude with others as well if they wish to (Figure 7.14).

The app also reminds users to enter their gratitude (Figure 7.15). Users also receive randomly a suggestion notification that motivates users to do an act of kindness with an encouragement statement to do it (Figure 7.16). The app also asked user about their experiences and feeling weakly by recording their voice (Figure 7.17). Figure 7.18 show the setting screen.

Table 7.2 Features in each version

Versions	Figures																	
	(7.1)	(7.2)	(7.3)	(7.4)	(7.5)	(7.6)	(7.7)	(7.8)	(7.9)	(7.10)	(7.11)	(7.12)	(7.13)	(7.14)	(7.15)	(7.16)	(7.17)	(7.18)
Tailored single-strategy	√	√	√		√			√	√	√	√					√	√	√
Tailored multi-strategy	√	√	√		√	√		√	√	√	√			√		√	√	√
Mixed-strategy	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

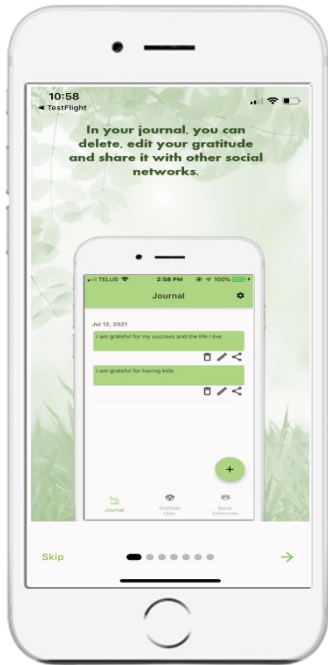


Figure 7.1 Onboarding of the app

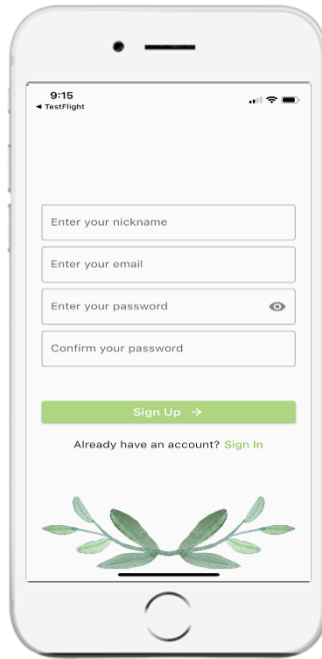


Figure 7.2 Creating an account in the app

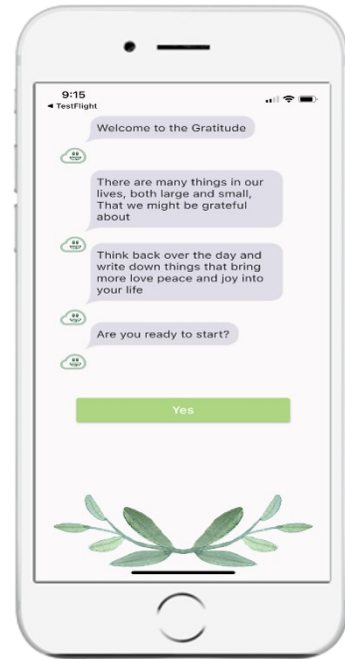


Figure 7.3 introducing the user to gratitude

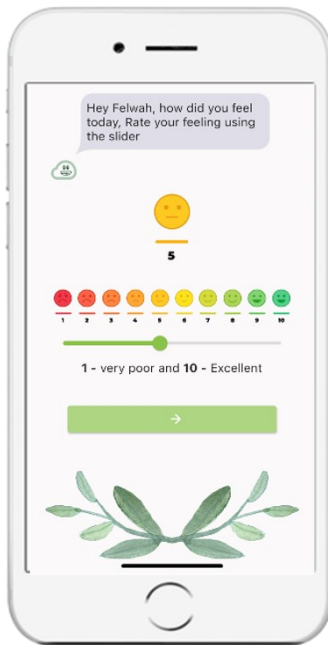


Figure 7.4 Rating the feeling before gratitude

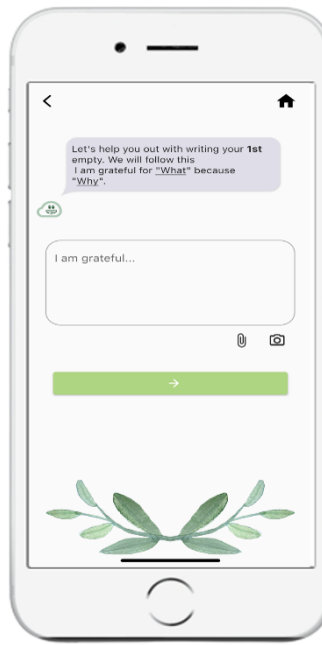


Figure 7.5 Entering the gratitude and attaching or taking a picture

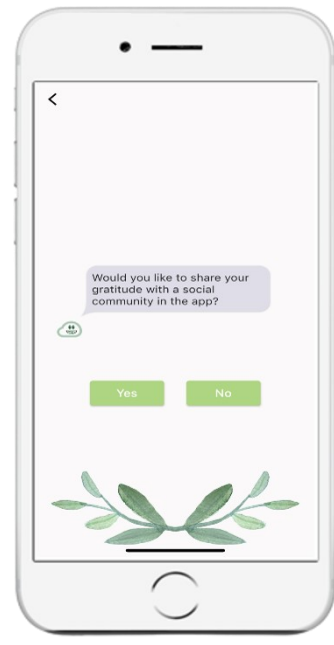


Figure 7.6 Allowing user to share their gratitude

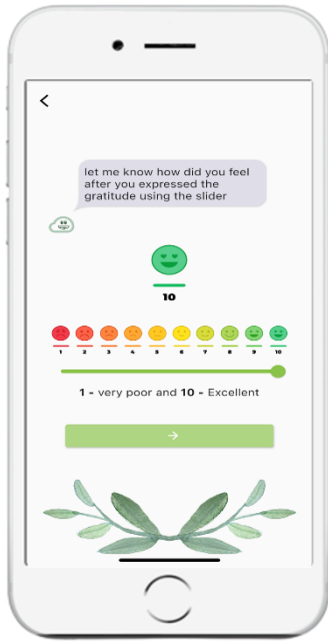


Figure 7.7 Rating feelings after expressing gratitude

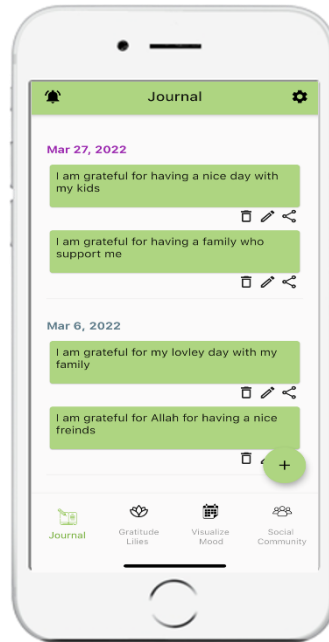


Figure 7.8 The journal showing gratitude entries

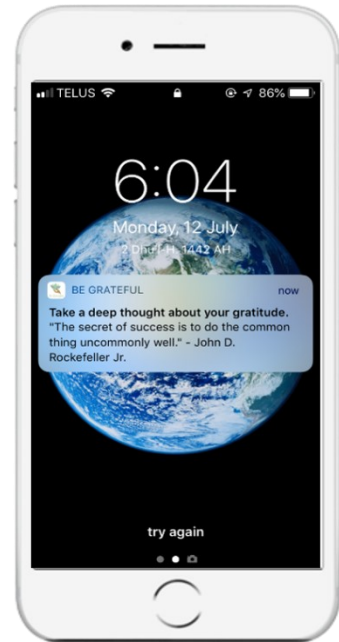


Figure 7.9 positive quote related to previous gratitude



Figure 7.10 The gratitude lilies showing lily flower for each gratitude entry

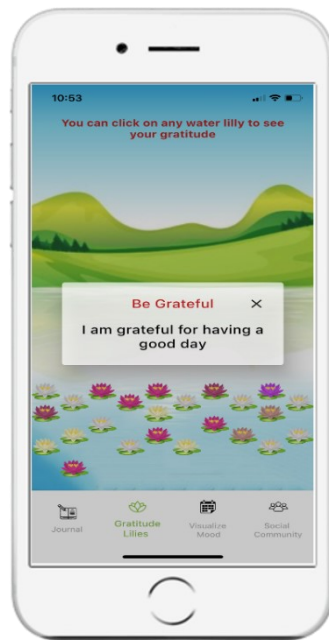


Figure 7.11 Clicking on any lily shows stored gratitude

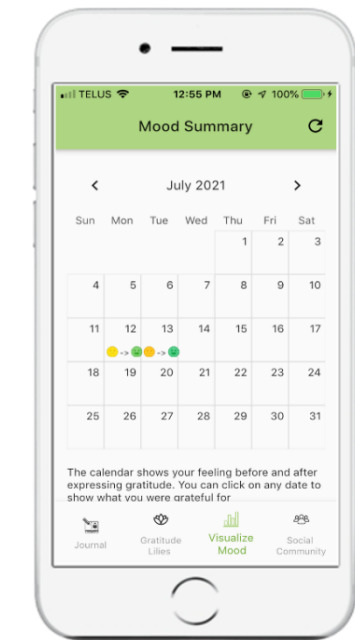


Figure 7.12 Mood summary shows feelings before and after expressing gratitude

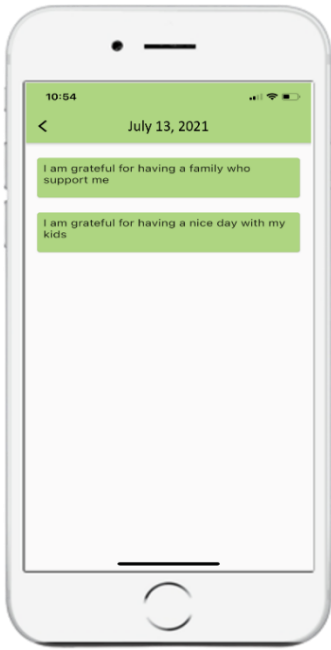


Figure 7.13 Clicking on any date shows stored gratitude

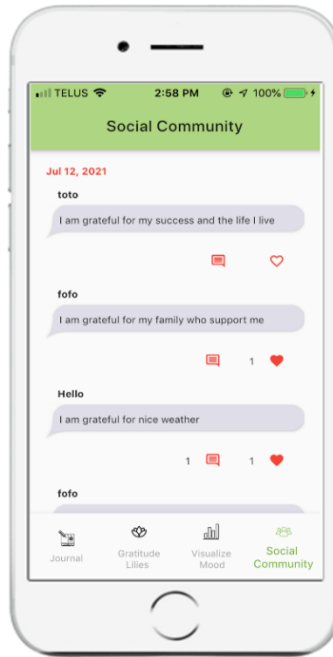


Figure 7.14 Social community screen

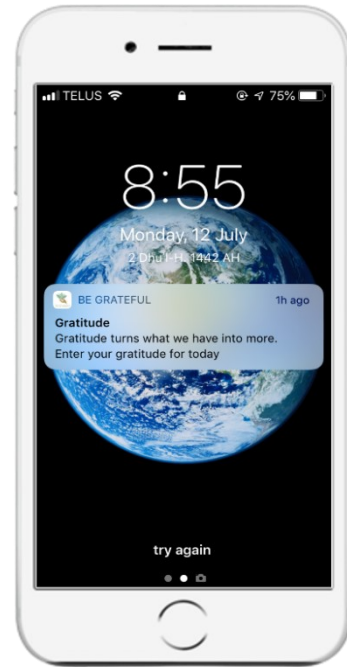


Figure 7.15 Reminder notification



Figure 7.16 Suggestion notification

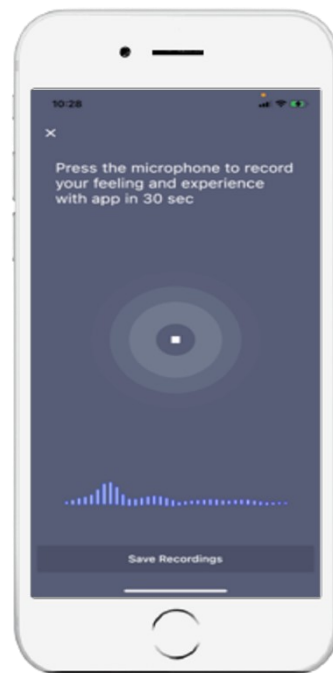


Figure 7.17 Recording experience & feeling weekly

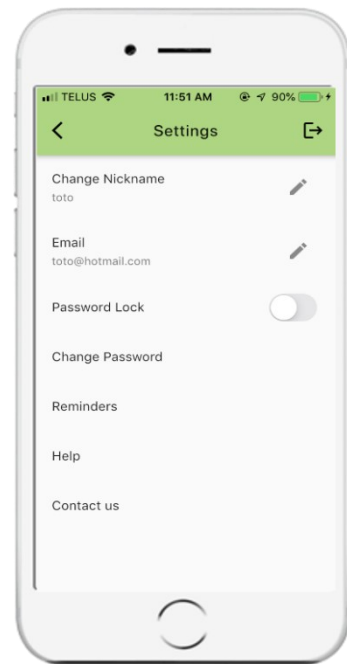


Figure 7.18 Setting screen



## 7.6 Chapter Summary

This Chapter aims to evaluate the usability of *Be Grateful*, an app-based gratitude intervention, from the perspective of end-users to identify existing design, functionality, and usability issues and elicit their views and experiences with the app. I evaluated the app using a quantitative (using the SUS scale), and a qualitative study, which is conducted with 14 participants who have experienced mental health issues based on self-diagnosis. The SUS results show that the app was successful. Also, the qualitative study revealed that participants appreciated the simplicity of the app and provided positive feedback about the layout as well as other app functions. Usability data from this study broadly supported the use of *Be Grateful App* for promoting mental wellbeing, with particularly positive feedback received from the end-user. Based on the results, I provide design implications for future work in the area of designing an interactive mobile application for health and wellness, with a focus on mental health interventions. Moreover, the usability data enables me as researcher to further develop and refine the *Be Grateful* app before moving into the efficacy trial.

This chapter describes the usability testing study of the designed app and how the result was used to refine the app and arrive at the final design. In the next chapter, I present the evaluation method of the three versions of *Be Grateful app* including study design, measurement instruments and data collection and analysis process.

## CHAPTER 8: PERSONALITY-BASED MODEL-DRIVEN PERSUASIVE MENTAL HEALTH APP EVALUATION

**Chapter Overview:** The previous chapter (Chapter 7) describes the usability testing of *Be Grateful app* and how the result was used to refine the app and arrive at the final design. This chapter presents an evaluation of a personality-based model-driven persuasive mental health app (*Be Grateful*). This chapter describes the study design method, measurement instruments, data collection and data analysis process.

**The evaluation has three main aims:**

- 1) *Is there any value in tailoring persuasive mental health apps using a single strategy?*
- 2) *Is there a need to employ multiple persuasive strategies to improve the effectiveness of the intervention?*
- 3) *Does employing inappropriate persuasive strategies cancel the effectiveness of the appropriate persuasive strategy when they are employed together in persuasive mental health apps?*

### 8.1 The Study design Method

I evaluated the efficacy of *Be Grateful app* with respect to its ability to promote positive mental health behaviours, improve mental well-being and reduce perceived stress using a quantitative study. Also, I conducted a qualitative interview to gain a more comprehensive understanding of the participants' experience using the app. This section presents the detail of the quantitative and qualitative study methods, data collection and analysis.

#### 8.1.1 Quantitative Part of the study

To measure the effectiveness of *Be Grateful app* concerning its ability to promote positive mental health behaviour, I would ideally have to monitor users' mental health behaviour before using the *Be Grateful app* and after using it. Then I compare these values over time. This is, however, not feasible in the context of this research because it is resource-intensive to conduct such research, which is beyond the scope of this research.

The common practice in the literature is to assess the effectiveness of health interventions by measuring their effect on an individual's Attitude, Self-efficacy, and Intention towards healthy behaviour, which are the three main predictors of behaviour change [170], [8]. Research has shown that a specific attitude towards the behaviour in question can predict specific behaviours very well. For example, Kraus [118] conducted a meta-analysis of 88 attitude-behaviour studies and found that attitude significantly predicts future behaviour. Similarly, self-efficacy, which explains one's belief about their capability to do the behaviour in question [214], has been found to be an essential variable in understanding and predicting actual behaviour in healthy behaviour domains [85]. Moreover, some behaviour theories, such as the Theory of Planned Behaviour (TPB), assume that behaviour intention is the immediate antecedent of actual behaviour [8]. Therefore, to determine the effectiveness of *Be Grateful app*, I measured its efficacy concerning promoting a positive change in Intention, Self-efficacy, and Attitude regarding mental health behaviour. Positive mental health behaviour refers to a behaviour that contributes to promoting mental health, “ which is defined as an integration of both individual well-being and of being fully functional [92]”.

Moreover, in reviewing the literature, many studies assessing the effectiveness of mental health interventions by measuring the improvement in mental well-being [234], [26], [70], [25], [96], [89] and reducing the perceived stress [136], [96], [234], [51], [197], [118], [83]. Therefore, I also measured the efficacy of *Be Grateful app* by investigating whether there is an improvement in participants' mental well-being and reduced the perceived stress.

In persuasive and behaviour change literature, pre and post-test measured the following exposure to intervention is the dominant way of evaluating change of attitude, self-efficacy, intention, mental well-being, and stress level. I adopted this method to assess the effectiveness of the *Be Grateful app*. Participants answered pre-(baseline) and post-(exit) surveys before and after using their randomly allocated version of *Be Grateful app* once.

In addition, to make any system persuasive, it should provide value and usefulness for the users, hold the users' interest and give users a feeling of competence. I also examined the perceived persuasiveness of the *Be Grateful app* with respect to its ability to motivate the

desired change in mental health behaviour. Therefore, I examined users' experience and the perceived persuasiveness of the Be Grateful app after using the app.

### **8.1.2 Qualitative Part of the Study**

The qualitative part, which involved an online interview with 8-10 randomly-selected participants from each group see the (Appendix E), aimed to gain a more comprehensive understanding of participants' experience using the app.

## **8.2 Study Design**

I conducted the study online to evaluate the effectiveness of the three versions of *Be Grateful app*. At the beginning of the study, participants read and gave their consent to the study, and their personality traits were assessed using the personality traits questionnaire [186]. Then, participants completed a pre-survey containing questions for (1) participants' demographics; (2) and three scales based on the theory of planned behavior to assess baseline attitude, intention, and self-efficacy towards mental health and emotional wellbeing. (3) questions to assess baseline mental well-being (4) questions to assess baseline perceived stress (Appendix E).

Depending on the participants' personality trait – as obtained using the personality traits questions – participants were categorized into three major experimental groups: The Extraversion group (Tailored single-strategy group, Tailored multi-strategy group), the Openness group (Contra-tailored single-strategy group, Mixed-strategy group), and the Control group (Control group-single, Control group-mixed). The Extraversion groups consisted of people with a high level of Extraversion; the Openness groups consisted of people with a high level of Openness; Control groups consisted of other personality traits (Conscientiousness, Agreeableness and Neuroticism), and those whose personality trait was not defined (have equal value for two or more personality traits).

### **8.2.1 Assign Participants to Personality Traits**

Before conducting the study, I asked 25 people to answer the personality traits questions to determine the most appropriate criteria for classifying users by personality trait. After

calculating the score for each dimension of personality traits (5 total), I found that if the difference between the highest score of one dimension and the other dimensions is 0.5, it gave more variation in users' personality types. That means I was able effectively to classify participants into different personality types. After consultation with experts in this area, I decided to classify participants based on their highest score on the five personality dimensions as done in the previous study [23], with at least 0.5 difference between the highest score in one dimension and the other four dimensions. If there was no difference between the scores in two or more dimensions (having equal score) of a user's personality traits, the personality trait of the user was considered undefined, and the user was moved to the Control groups.

I used a between-subject design to evaluate the effectiveness of:

1. The tailored single-strategy version of persuasive mental health app.
2. The tailored multi-strategy persuasive mental health app compared to tailored single-strategy version.
3. The mixed-strategy version persuasive mental health app.

In this regard, I developed six experimental group conditions (See Table 8.1).

Table 8.1 Experimental group condition

<b>Conditions</b>	<b>Definition</b>
Tailored single-strategy (TS) group	Participants in this experimental condition are people with high level of Extroversion. Participants with this personality trait were randomly assigned to this condition and used a tailored single-strategy version of the persuasive mental health app, i.e., app that was implemented using a single strategy that the personality-based model suggested would be persuasive, depending on their personality type as highlighted in Chapter 5

<b>Conditions</b>	<b>Definition</b>
Contra-Tailored single-strategy (CTS) group	Participants in this experimental condition are people who are highly open to new experiences. Participants with this personality trait were randomly assigned to this condition and used a contra-tailored version of the persuasive, i.e., an app that was implemented using a single strategy that the personality-based model suggested would not be persuasive, depending on their personality type as highlighted in Chapter 5
Tailored multi-strategy (TM) group	Participants in this experimental condition are people with high level of Extroversion. Participants with this personality trait were randomly assigned to this condition and used a tailored multi-strategy version of the persuasive mental health app, i.e., app that was implemented using two strategies that the personality-based model suggested would be persuasive, depending on their personality type as highlighted in Chapter 5
Mixed-strategy (M) group	Participants in this experimental condition are people who are highly open to new experiences. Participants with this personality trait were randomly assigned to this condition and used a mixed- strategy version of the persuasive app, i.e., an app that was implemented using four strategies (two strategies that the personality-based model suggested would not be persuasive and other two strategies that the personality-based model suggested would be persuasive), depending on their personality type as highlighted in Chapter 5
Control group-single (CS)	Participants in this experimental condition were people of other personality traits (Conscientiousness, Agreeableness

<b>Conditions</b>	<b>Definition</b>
	and Neuroticism), and those whose personality trait was not defined (have equal value for two or more personality traits. Participants in this condition were randomly assigned to use the tailored single-strategy without considering their personality trait or strategy preference.
Control group-mixed (CM)	Participants in this experimental condition were people of other personality traits (Conscientiousness, Agreeableness and Neuroticism), and those whose personality trait was not defined (have equal value for two or more personality traits. Participants in this condition were randomly assigned to use mixed-strategy without considering their personality trait or strategy preference

Participants were randomly assigned depending on their personality type. Half of the participants belonging to the Extraversion trait were randomly assigned to the Tailored single-strategy group and the remaining half were assigned to the Tailored multi-strategy group. Moreover, half of all the participants belonging to the Openness trait were randomly assigned to the Contra-tailored single-strategy group and the remaining half were assigned to the Mixed-strategy group. The Control group-single was assigned randomly to Tailored single-strategy version and the Control group-mixed was assigned randomly to Mixed-strategy version.

To achieve this, each of the three personality groups (Extraversion, Openness, and Control) was associated with two surveys. Hence, in total, I created a total of six separate surveys – two for each personality group. The six surveys contained the same set of questions. However, within the survey, each participant was directed to download and use the appropriate app version as determined by their randomly assigned experimental condition. To determine each participant’s personality trait in order to assign them to the appropriate experimental condition, I automated the Big Five Inventory -10 (BFI-10) for

classifying users to various traits [186] using a custom script written on a webpage. The BFI-10 was utilized to assess the five personality dimensions using a 5-point Likert scale (1: strongly disagree, 5: strongly agree). Each dimension was evaluated using two items (one item was reverse-scored). Two items with a high total score indicate a high trait level. This instrument was only used for pre-testing.

Then participants used the app to express their gratitude at least four times a week over five weeks. In the beginning, the app shows a demo to first-time users that helps them get started with an app and understand how the app can be used. The participants gained a water lily flower in a pond each time they expressed gratitude. They also received an encouraging notification suggesting a simple act of kindness. I also collected weekly voice recordings regarding users' feelings and experiences with the app during the five weeks of app usage.

After using the app for five weeks, participants completed the same scales assessing their attitude, intention, and self-efficacy towards mental health and emotional well-being as well as mental well-being, and perceived stress. I also used the intrinsic motivation inventory (IMI) (14 items)—a validated scale for measuring enjoyment, the usefulness of the app, invested effort, perceived competence, and tension [145] to assess app user experience (Appendix E). I also assessed the persuasiveness of the app using a perceived persuasiveness scale which is a validated instrument (Appendix E). For each participant, I collected two mean values for their mental well-being, and stress level, attitude, self-efficacy, and intention: One indicating their baseline value and the other indicating their post-intervention mental well-being, and stress level, attitude, self-efficacy, and intention towards positive mental and emotional wellbeing. Participants were asked if they would like to volunteer for an online interview. At the end of the study, each participant received \$15.00 CAD dollar compensation in a form of a gift card. Figure 8.1 shows the flow of the evaluation study design.



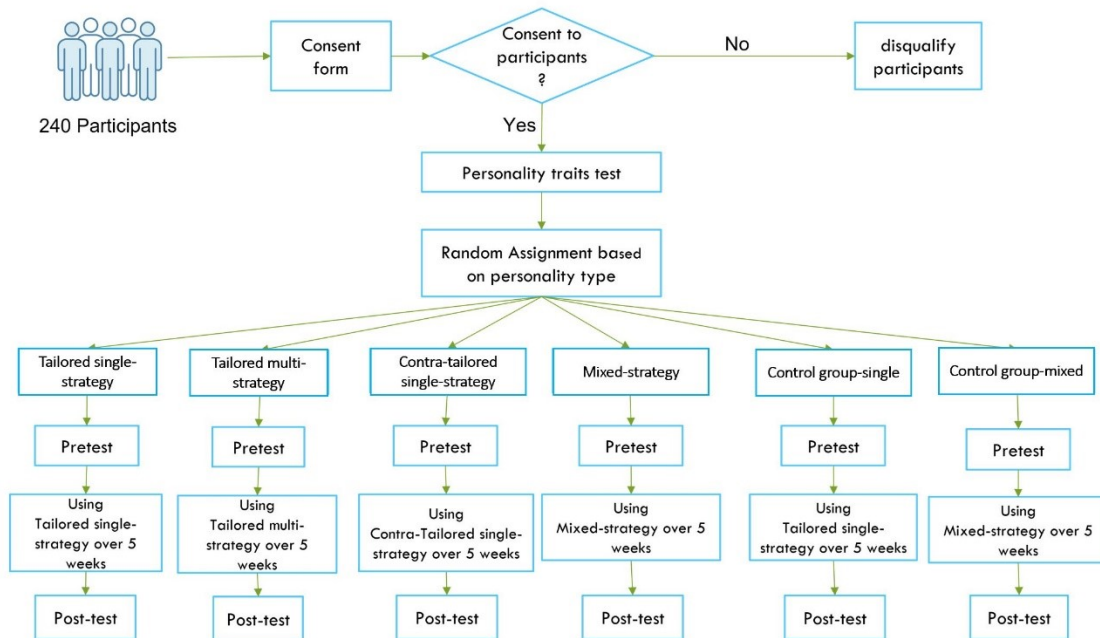


Figure 8.1 The Flow of the Evaluation Study Design

## 8.2.2 Measurement Instrument Evaluation

### 8.2.2.1 Attitude Towards Mental and Emotional Health

Ajzen defines attitude toward a behaviour as " a person's overall evaluation of performing the behaviour in question." [7]. This refers to a person's overall feeling, belief, or opinion of approval or disapproval regarding the in-question behaviour. The pre and post surveys used a seven-item semantic differential scale to measure attitudes toward mental and emotional health. An example of a question in the attitude towards mental and emotional health scale is "*Promoting your mental and emotional well-being by focusing on positive and good things in the next two weeks would be?*" All questions were evaluated using a 7-point Likert scale with anchoring adjectives that included good – bad, pleasant – unpleasant, beneficial – harmful, enjoyable – unenjoyable, valuable – worthless, useful – useless, and important – unimportant. The questions of the attitude scale used to evaluate participants' attitudes toward mental and emotional health were adapted from [7], [170].

For each participant, I got two mean values relating to their attitude toward mental and emotional health: one describing their attitude toward mental and emotional health at baseline (obtained from the pre-test survey) and the other from the post-survey describing their attitude toward mental and emotional health after the intervention (obtained from the post-test survey).

### **8.2.2.2 Intention Toward Mental and Emotional Health**

The pre and post-survey included seven questions adapted from [7] [170] [132] to assess individuals' intentions regarding mental and emotional health. All seven-item were evaluated using a 7-point Likert scale ranging from "1 = Extremely Unlikely" to "7 = Extremely Likely." An example of a question in the health and emotional intention scale is "I intend to avoid negative thinking during the next two weeks". From the surveys, for each participant, I got two mean values related to health and emotional intention: One indicating their baseline health and emotional intention – obtained from the pre-survey – and the other from the post-survey indicating their health and emotional intention after the intervention.

### **8.2.2.3 Self-Efficacy Towards Mental and Emotional Health**

Self-efficacy is a term used to describe a person's confidence in their ability to perform the behaviour in question [214]. The baseline and post-surveys included five questions adapted from [51,129,149] to assess self-efficacy regarding mental and emotional health. All questions were measured using a 7-point Likert scale ranging from "1 = Strongly disagree" to "7 = Strongly agree" for participant agreement. An example of a question in the self-efficacy towards mental and emotional health scale is, "I am confident that I can focus on positive and good things during bad days". For each participant, I got two mean values related to self-efficacy towards mental and emotional health: one indicating their baseline self-efficacy towards mental and emotional health (obtained from the pre-survey), and the other from the post-survey indicates their self-efficacy towards mental and emotional health after intervention.

#### **8.2.2.4 The Perceived Stress Scale (PSS)**

The Perceived Stress Scale (PSS-10) was used to assess the psychological stress levels of participants. The baseline and post-surveys included the PSS-10 which, is a well-validated stress measurement instrument with items designed to assess how unpredictable, uncontrollable, and overburdened individuals find their lives to be [52]. All ten questions were measured using a 5-point Likert scale ranging from “0 = Never” to “4 = Very often”. An example of a question in the Perceived Stress Scale is “In the last month, how often have you been upset because of something that happened unexpectedly?” For each participant, I got two mean values related to perceived stress: one indicating their baseline stress level before the intervention (obtained from the pre-survey), and the other from the post-test survey indicates their stress level after intervention.

#### **8.2.2.5 Warwick-Edinburgh Mental Well-Being Scale (WEMWBS)**

Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) is a 14-item scale designed to measure the mental well-being of participants [215]. It requires respondents to indicate the frequency of positive psychological experiences over the previous two weeks on a five-point scale ranging from None Of The Time (1) to All Of The Time (5). Example items include “I’ve been feeling optimistic about the future” and “I’ve been thinking clearly”. For each participant, I got two mean values related to mental well-being: one indicating their baseline mental wellbeing before the intervention (obtained from the pre-survey), and the other from the post-test survey indicates their mental well-being after intervention.

#### **8.2.2.6 User Experience Measure (Intrinsic Motivation Inventory (IMI))**

I measured users’ experience using the Intrinsic Motivation Inventory (IMI) [145] a standardized scales commonly used for assessing player experience and was included in the post-survey. IMI is a multidimensional scale used in measuring participants’ subjective experiences with performing a target task. The IMI subscales were assessed using 14 questions adapted from [145]. Participants responded by showing their agreement to the questions on a 5-point Likert scale ranging from “1 = Strongly disagree” to “5 = Strongly

agree”. Example items include " I enjoyed the Be Grateful app very much " and " I think I am pretty good at using Be Grateful app." This instrument was only used for post-testing.

### **8.2.2.7 Perceived Persuasiveness Scale**

I measured the perceived persuasiveness of Be Grateful app using the perceived persuasiveness scale, which is a validated instrument. I adapted the perceived persuasiveness scale from [218] and it has been used in other previous persuasive studies [17],[167], [11], [14] [160]. The scale consists of five statements: “This app influenced me to focus on positive things in my life.”, “This app convinced me to be positive and optimistic”, “This app is personally relevant for me.”, “This app made me reconsider my mental health and emotional well-being”, and “This app motivated me to think positively and to be grateful for small things in my life”. This instrument was only used for post-testing.

### **8.2.3 Data Collection**

I recruited participants for this study using many approaches. I recruited participants via email (academic environments), and social networks (Facebook, Twitter, and WhatsApp). I developed an online survey hosted on Dal opinio. I included several attention-check questions in the survey to ensure participants were reading all the items carefully and actively considering their answers. The analysis did not include responses from participants who got the attention questions wrong. Before the main study, I conducted usability study on 14 participants to test the usability of *Be Grateful app* (see Chapter 7 for more details).

### **8.2.4 Participants’ Demographic Information**

A total of 240 participants participated in the study. Our participants are people who aged 18 and above and have experienced mental health issues such as stress, low mood, fear, worry, depression, anxiety and other forms of mental health-related issues based on self-diagnosis. People who are clinically diagnosed with any type of mental health illness and see a psychologist regularly were not allowed to participate in the study because including

those people is a confounding variable that could interfere with the intervention. The participants' demographic information is summarized in Table 8.2. Each participant received \$15 CAD dollar compensation. Notably, some participants did not accept the gift card or donated it to the study as a way of showing appreciation for the study (See a sample of their emails in the appendix D).

The result of our analysis shows that 12% of the participants in our study had used an app to manage their mental health issues in the past and 26% of the participants are keeping a journal of what you are thankful for. I had a relatively diverse population in terms of gender, age, education level, see Table 8.2. However, most of our participants are young adults between 18 and 35 years of age and relatively educated.

Table 8.2 demographic information

<b>Total participants = 240</b>		
Gender	Tailored single-strategy group	Female (55%), Male (45%)
	Tailored multi-strategy group	Female (48%), Male (52%)
	Contra-tailored single-strategy group	Female (31%), Male (69%)
	Mixed-strategy group	Female (38%), Male (62%)
	Control group-single	Female (67%), Male (33%)
	Control group-mixed	Female (45%), Male (55%)
Age	Tailored single-strategy group	18-24 (64%), 25-34(31%), 35-44 (5%), 45-54 (0%), 55-64 (0%), above 65 (0%)
	Tailored multi-strategy group	18-24 (48%), 25-34(40%), 35-44 (10%), 45-54 (0%), 55-64 (0%), above 65 (2%)

<b>Total participants = 240</b>		
	Contra-tailored single-strategy group	18-24 (14%), 25-34(55%), 35-44 (26%), 45-54 (5%), 55-64 (0%), above 65 (0%)
	Mixed-strategy group	18-24 (17%), 25-34(76%), 35-44 (7%), 45-54 (7%), 55-64 (non), above 65 (non)
	Control group-single	18-24 (12%), 25-34(62%), 35-44 (24%), 45-54 (2%)
	Control group-mixed	18-24 (14%), 25-34(67), 35-44 (19%)
Education	Tailored single-strategy group	High School or equivalent (2%), College diploma (36%), Bachelor's degree (48%), Master's degree(12%), PhD (2%)
	Tailored multi-strategy group	High School or equivalent (10%), College diploma (36%), Bachelor's degree (48%), Master's degree(7%), PhD (0%)
	Contra-tailored single-strategy group	High School or equivalent (14%), College diploma (5%), Bachelor's degree (55%), Master's degree(26%), PhD (14%)
	Mixed-strategy group	High School or equivalent (Non), College diploma (24%), Bachelor's degree (38%), Master's degree(31%), PhD (7%)
	Control group-single	High School or equivalent (5%), College diploma (7%), Bachelor's degree (57%), Master's degree(24%), PhD (7%)
	Control group-mixed	High School or equivalent (7%), Bachelor's degree (43%), Master's degree (38%), PhD (12%)

<b>Total participants = 240</b>		
Mental health issues	Tailored single-strategy group	Stress (33%), Worry (55%), (Negative feelings (64%), Negative thoughts (64%), Low moods (50%), Fear (62%) Anxiety (36%), Depression (38%)
	Tailored multi-strategy group	Stress (52%), Worry (64%), (Negative feelings (55%), Negative thoughts (55%), Low moods (52%), Fear (69%) Anxiety (31%), Depression (26%)
	Contra-tailored single-strategy group	Stress (50%), Worry (62%), (Negative feelings (48%), Negative thoughts (60%), Low moods (52%), Fear (57%) Anxiety(60%), Depression (52%)
	Mixed-strategy group	Stress (48%), Worry (33%), (Negative feelings (40%), Negative thoughts (17%), Low moods (33%), Fear (29%) Anxiety(31%), Depression (19%)
	Control group-single	Stress (71%), Worry (50%), (Negative feelings (38%), Negative thoughts (43%), Low moods (60%), Fear (24%) Anxiety(40%), Depression (40%)
	Control group-mixed	Stress (74%), Worry (67%), (Negative feelings (52%), Negative thoughts (40%), Low moods (52%), Fear (36%) Anxiety(48%), Depression (33%)
	Tailored single-strategy group	2%

Total participants = 240		
Using Mental health app	Tailored multi-strategy group	5%
	Contra-tailored single-strategy group	Non
	Mixed-strategy group	Non
	Control group-single	14%
	Control group-mixed	7%

### 8.3 Data Analysis

This thesis has three main goals which are:

1. Examining the effectiveness of the tailored single-strategy of persuasive mental health app.
2. Comparing the effectiveness of the tailored single-strategy and tailored multi-strategy persuasive mental health app.
3. Examining the effectiveness of the mixed-strategy version persuasive mental health app.

To achieve this, I used several well-known analytical tools and procedures. In this section, I summarize the various steps taken to analyze the data.

#### 8.3.1 Overall user's Experience and Persuasiveness of Using Be Grateful app

To improve people's mental and emotional well-being, I need to motivate them and keep them engaged while using the app. For that reason, I started examining the participants' overall experience using the app and their experience using the individual versions of Be Grateful app. To achieve this, I ran one-sample t-tests on the combined data of IMI to obtain an overall experience with using Be Grateful app. I then performed one-sample t-



tests separately on the data from using the different versions of the app. I compared this data to an optimistic-neutral rating of 4 for the IMI subscales.

Then, I examined the overall persuasiveness of *Be Grateful* app and the persuasiveness of each version of the app. To achieve this, I ran one-sample t-tests on the combined data of the perceived persuasiveness to obtain an overall persuasiveness of Be Grateful app. I then performed one-sample t-tests separately on the data from using the different versions of the app. I compared the data to an optimistic-neutral rating of 4 on the perceived persuasiveness scale.

### **8.3.2 Examining the Effectiveness of Tailored Single-strategy Version**

- The first step was to examine whether the Tailored single-strategy group showed more positive changes in attitude, self-efficacy, and intention than the Contra-tailored single-strategy group and Control group-single (who were randomly assigned to the single-strategy version). To achieve this, I performed the following analysis.
  - Prior to examining the impact of the *Be Grateful* app on attitude, self-efficacy, and intention, I assessed the internal consistency of the scales using reliability analysis [147]. Given the positive outcomes, the data are suitable for analysis.
  - Then, I employed a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects factor (Time: pre, post), and groups as a between-subjects factor (groups: Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single) on attitude, intention, and self-efficacy (Dependent variables).
- The second step was to examine whether the Tailored single-strategy group showed more improvement in mental well-being and reduced perceived stress than the Contra-tailored single-strategy group and Control group-single (randomly assigned to this version). To achieve this, I employed a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects (Time: pre and post) factor, and groups as a between-subjects factor (groups: Tailored single-

strategy group, Contra-tailored single-strategy group, Control group-single) on mental well-being, and perceived stress (Dependent variables).

- The third step was to examine participants' experiences with the app in different groups. I conducted a one-way ANOVA with groups (Tailored single-strategy group, Contra-tailored single-strategy group and Control group-single) as a between-subject factor and experience (interest/enjoyment, value/usefulness, effort /importance, pressure/tension, and perceived competence) as dependent measures.
- The fourth step was to examine the persuasiveness of the app by different groups. I conducted a one-way ANOVA with groups ((Tailored single-strategy group, Contra-tailored single-strategy group and Control group-single) as a between-subject factor and persuasiveness value as dependent measures.
- Following findings of significant effects I performed a planned pairwise comparison, using Bonferroni for adjusting the degrees of freedom for multiple comparison, to determine the groups that significantly differ from each other.

### **8.3.3 Comparing the Effectiveness of Tailored Multi-Strategy Version and Tailored Single-Strategy Version**

- The first step was to examine whether the Tailored multi-strategy group showed more positive change in attitude, self-efficacy, and intention than the Tailored single-strategy group. To achieve this, I employed a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects (pre and post) factor, and intervention type as a between-subjects (tailored single-strategy version, tailored multi-strategy version) on attitude, intention, and self-efficacy (Dependent variables).
- The second step was to examine whether the Tailored multi-strategy group showed more improvement in mental well-being and reduced stress than the tailored single-strategy group. To achieve this, I employed a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects (pre and post) factor, and intervention type as a between-subjects factor (tailored single-strategy version,

tailored multi-strategy version) on mental well-being and perceived stress (Dependent variables).

- The third step was to examine whether using the tailored multi-strategy version increased the user experiences compared to using the tailored single-strategy version). To achieve this, I conducted an independent t-test to examine participants' experience with the tailored single-strategy version, compared to the tailored multi-strategy version.
- The fourth step was to examine whether the tailored multi-strategy group perceived the app's persuasiveness higher than the tailored single-strategy group.
- Following findings of significant effects I performed a planned pairwise comparison, using Bonferroni for adjusting the degrees of freedom for multiple comparison, to determine the groups that significantly differ from each other.

#### **8.3.4 Examining the Effectiveness of Mixed-strategy Version**

The first step was to examine whether the Mixed-strategy group showed less positive changes in attitude, self-efficacy and intention than the Control group-mixed who were randomly assigned to the app. To achieve this, I employed a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects (pre and post) factor, and groups as between-subjects (Mixed-strategy group and Control group-mixed) on attitude, intention, and self-efficacy (Dependent variables).

The second step was to examine whether the mixed-strategy group showed less improvement in mental well-being and reduced stress levels than users in the Control group-mixed who were randomly assigned to the app. To achieve this, I employed a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects (pre and post) factor, and groups as between-subjects (Mixed-strategy group and Control group-mixed) on attitude, intention, and self-efficacy (Dependent variables).

- The third step was to examine participants' experiences with the app in different groups. I conducted a one-way ANOVA with a group (Mixed-strategy group and Control group-mixed) as between-subject factors and experience

(interest/enjoyment, value/usefulness, effort /importance, pressure/tension, and perceived competence) as dependent measures.

- The fourth step was to examine whether the Mixed-strategy group perceived the app's persuasiveness as lower than the Control group-mixed after using the app. I conducted a one-way ANOVA with a group (Mixed-strategy group and Control group-mixed) as between-subject factors and perceived persuasiveness as the dependent measure.
- Following findings of significant effects I performed a planned pairwise comparison, using Bonferroni for adjusting the degrees of freedom for multiple comparison, to determine the groups that significantly differ from each other.

All ANOVA were performed after validating the data for the assumptions of ANOVA.

### **8.3.5 The interview data:**

The data collected through the online interviews were analyzed using thematic analysis. The thematic analysis enables us to analyze the data in a systematic manner to identify patterns in the text while taking into account the context of what participants said, thereby allowing for a more precise interpretation of the data. The following steps were taken to conduct a thematic analysis, as outlined by Braun and Clarke [19]: (1) becoming familiar with the data, (2) generating initial codes, (3) searching for themes, (4) defining themes, (5) iteratively reviewing themes, and (6) writing up the results.

Specifically, two researchers independently coded sample transcripts by reading and rereading (iteratively) the sample transcripts to identify codes using open coding. The two researchers then compared the initial codes, which were subsequently expanded, developed, and modified as new codes emerged. Disagreements between the two researchers were resolved through conversation. The initial codes were used to code the remaining transcripts, and they were extended as necessary. For creating the themes, the two researchers systematically refined the themes by going back and forth between the data and the coding framework. I provided quotes as specific examples from each theme within the results section. To preserve participants' privacy and anonymize the responses,

I identify participants by acronym the group name and anonymized IDs (e.g., TS-P1, CTS-P2, CS-P3 etc.) to represent participant (1) Tailored single-strategy group (TS), (2) Contra-tailored single-strategy group (CTS) and (3) Control group-single (CS), respectively).

This chapter presents an evaluation of a personality-based model-driven persuasive mental health app. In the next chapter, I present the results from a large-scale quantitative evaluation involving 240 users and a qualitative interview involving 65 users, which allow for a more comprehensive understanding of participants' experiences.

## CHAPTER 9: RESULTS OF PERSONALITY-BASED MODEL-DRIVEN PERSUASIVE MENTAL HEALTH APP EVALUATION

**Chapter overview:** The previous chapter (Chapter 8) presents an evaluation of a personality-based model-driven persuasive mental health app (*Be Grateful*). In this chapter, I present the results from both quantitative and qualitative evaluations of *Be Grateful app*<sup>7</sup>. Specifically, in the following subsections:

**First,** I provide the findings of the overall user experience from using *Be Grateful* app as measured by the IMI subscales of interest/enjoyment, value/usefulness, effort/importance, pressure/tension, and perceived competence, as well as the individual version of the app.

**Second,** I provide the findings of the overall persuasiveness of *Be Grateful* app as measured by the perceived persuasiveness scale as well as the individual version of the app.

**Third,** I show the results of the effectiveness, user experience, and persuasiveness of using the tailored single-strategy version.

**Fourth,** I show the results of the effectiveness, user experience, and persuasiveness of the tailored multi-strategy version compared to the tailored single-strategy version.

**Fifth,** I show the results of the effectiveness, user experience, and persuasiveness of the Mixed-strategy version.

**Sixth,** I present the thematic analysis results of users' feedback.

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<sup>7</sup> Submitted in Alqahtani, F., & Orji, R. (submitted). Comparing the Effectiveness of Employing Single Versus Multiple Persuasive Strategy in Mental health Applications. In CHI 2023

## 9.1 Overall User Experience Using Be Grateful app

To answer **RQ1**: *How effective is Be Grateful app with respect to promoting a positive user experience overall?* I ran one-sample t-tests on the combined data of IMI to obtain an overall experience with using Be Grateful app. I then performed one-sample t-tests separately on the data from using the different versions of the app. I compared this data to an optimistic-neutral rating of 4 for the IMI subscales.

The overall experience with the Be Grateful app is presented in Figure 9.1 and Table 9.1. As shown in Table 9.1, The p values for all the variables measured under user experience using the app were less than 0.001. Therefore, I accept the alternative hypothesis, which states that there was a significant difference between the means of the variables measured and the test value (neutral = 4). In general, participants experienced quite high satisfaction with respect to enjoyment, competence, effort, and value and less pressure and tension while using the app. As shown in Table 9.1 and Figure 9.1, the t-values and the corresponding mean of the individual 5 subscales are well above the optimistic neutral rating of 4, except the pressure and tension subscale are less than the optimistic neutral rating of 4 because Be Grateful app is easy to use. Therefore, it caused little or no tension or pressure on the participants. Therefore, Be Grateful app was successful at inspiring positive experiences overall.

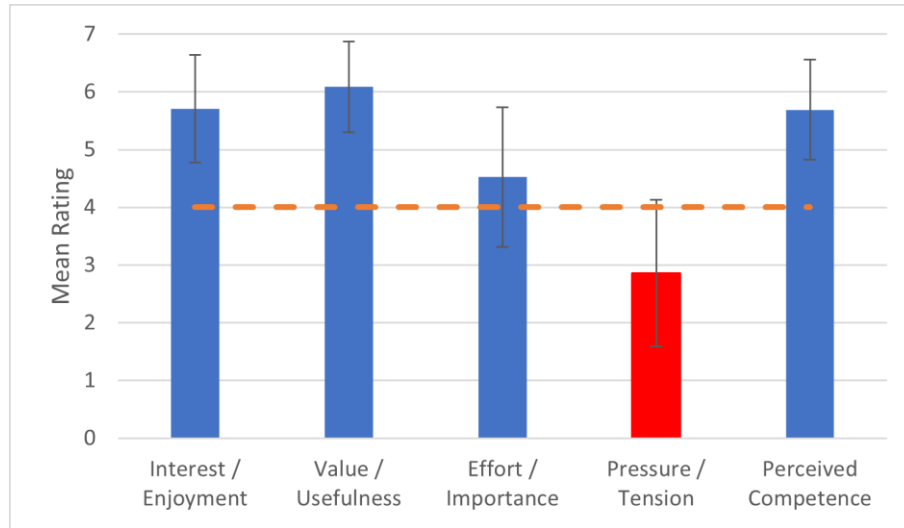


Figure 9.1 A bar graph of the mean of individual IMI subscales for the overall Be Grateful app use experience. Error bars represent a 95% confidence interval

Table 9.1 Means (M) and Standard Deviations (SD), Mean Difference (MD), t-values (t), and Significant levels (p) for all the variables under overall experience using Be Grateful app on a scale from 1 (low) to 7 (high)

	<b>M</b>	<b>SD</b>	<b>MD</b>	<b>t</b>	<b>p</b>
Interest / Enjoyment	5.70	0.94	1.70	28.75	<.001
Value / Usefulness	6.08	0.79	2.08	42.08	<.001
Effort / Importance	4.53	1.21	0.53	6.97	<.001
Pressure / Tension	2.88	1.27	-1.13	-14.11	<.001
Perceived Competence	5.69	0.87	1.69	30.72	<.001

Similarly, participants expressed positive experiences from using the individual versions of Be Grateful app with respect to interest/enjoyment, value/usefulness, effort/importance, pressure/tension, and perceived competence. As indicated in Table 9.2, the t-values and mean of the individual subscales generated by each version are all more than the optimistic, neutral rating of 4 except for the pressure/tension. This is a good because it shows that Be Grateful app is a straightforward app; therefore, it caused little or no tension



or pressure on the participants – Figures 9.2,9.3,9.4. Thus, each version of Be Grateful app was successful at inspiring positive experiences overall.

Table 9.2 Means (M) and Standard Deviations (SD), Mean Difference (MD), t-values (t), and Significant levels (p) for all the variables under overall experience using the three versions of Be Grateful app on a scale from 1 (low) to 7 (high).

<b>Versions</b>	<b>IMI measures</b>	<b>M</b>	<b>SD</b>	<b>MD</b>	<b>t</b>	<b>p</b>
Tailored single-strategy N= 126	Interest / Enjoyment	5.69	0.97	1.69	19.52	< .001
	Value / Usefulness	6	0.82	2	27.27	< .001
	Effort / Importance	4.48	1.28	0.48	4.20	< .001
	Pressure / Tension	2.72	1.27	-1.28	-11.30	< .001
	Perceived Competence	5.69	0.96	1.69	19.85	< .001
Tailored multi-strategy N= 42	Interest / Enjoyment	6.1	0.89	2.11	15.3	< .001
	Value / Usefulness	6.3	0.76	2.31	19.76	< .001
	Effort / Importance	4.4	1.21	0.36	1.94	0.05
	Pressure / Tension	2.5	0.91	-1.46	-10.34	< .001
	Perceived Competence	6.0	0.83	2.00	15.64	< .001
Mixed-strategy N= 84	Interest / Enjoyment	5.51	0.85	1.51	16.26	< .001
	Value / Usefulness.	6.10	0.73	2.10	26.47	< .001
	Effort / Importance	4.70	1.10	0.70	5.81	< .001
	Pressure / Tension	3.27	1.32	-0.73	-5.05	< .001
	Perceived Competence	5.52	0.71	1.52	19.72	< .001

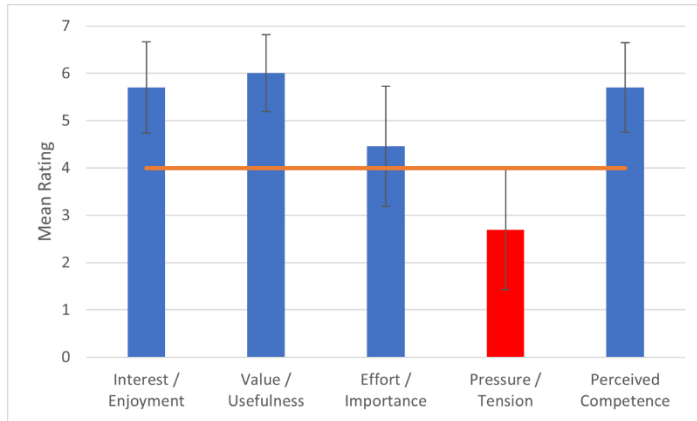


Figure 9.2 A bar graph of the mean of individual IMI subscales for Tailored single-strategy version. Error bars represent a 95% confidence interval

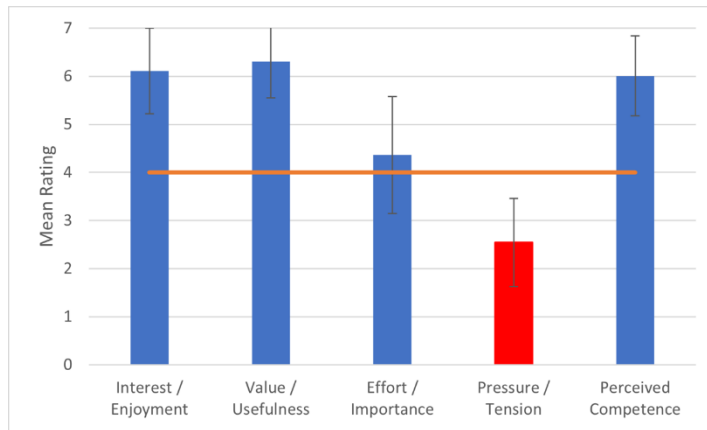


Figure 9.3 A bar graph of the mean of individual IMI subscales for the Tailored multi-strategy. Error bars represent a 95% confidence interval

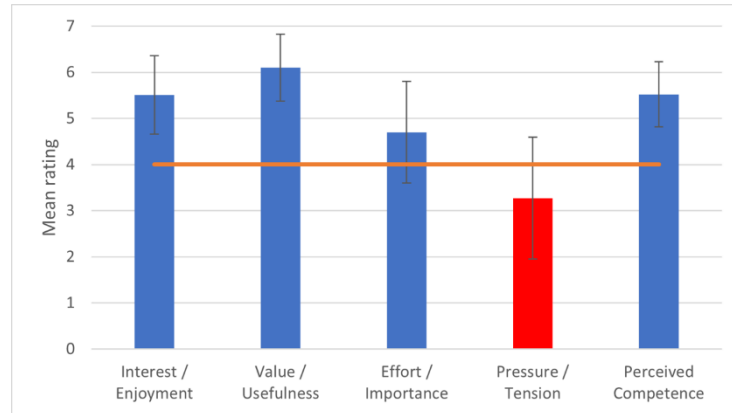


Figure 9.4 A bar graph of the mean of individual IMI subscales for the Mixed-strategy. Error bars represent a 95% confidence interval

## 9.2 Overall Persuasiveness of Be Grateful App

Before assessing the persuasiveness of Be Grateful app, I evaluated the internal consistency and reliability using Cronbach's alpha, which was higher than their threshold value of 0.7. The result indicates that the data were suitable for further analysis.

To answer **RQ2**: *How persuasive is Be Grateful app with respect to motivating mental health behaviour overall?* I ran one-sample t-tests on the combined data of the perceived persuasiveness to obtain an overall persuasiveness of Be Grateful app. I then performed one-sample t-tests separately on the data from using the different versions of the app. I compared the data to an optimistic-neutral rating of 4 on the perceived persuasiveness scale.

As shown in Table 9.3 and Figure 9.5, the mean score of the overall persuasiveness of Be Grateful app was higher than the neutral (point/mid-point) of 4.0, a statistically significant difference of perceived persuasiveness,  $t(40) = 26.384$ ,  $p < 0.001$ . The p-value for the overall persuasiveness of Be Grateful app was less than 0.001. Therefore, I accept the alternative hypothesis, which states that there was a significant difference between the mean obtained from the overall persuasiveness of Be Grateful app and the test value (neutral = 4). In general, Be Grateful app was very persuasive with respect to its ability to promote positive mental health behaviour.

Similarly, the mean score for the persuasiveness of each version of Be Grateful app was higher than the neutral score of 4.0 (Figure 9.5). The p-value for the persuasiveness of each version of Be Grateful app was less than 0.001 (Table 9.3). Therefore, I accept the alternative hypothesis, which states that there was a significant difference between the mean obtained from the persuasiveness of each version of Be Grateful app and the test value (neutral = 4). In general, each version of Be Grateful app was very persuasive concerning its ability to promote positive mental health behaviour.

Table 9.3 Means (M) and Standard Deviations (SD), Mean Difference (MD), t-values (t), and Significant levels (p) for all the persuasiveness of the overall Be Grateful app and the three versions of Be Grateful app on a scale from 1 (low) to 7 (high).

	<b>M</b>	<b>SD</b>	<b>MD</b>	<b>t</b>	<b>p</b>
Be Grateful (All versions)	5.80	1.08	1.80	26.49	<.001
Tailored single-strategy version	6.09	0.69	2.09	34.22	<.001
Tailored multi-strategy version	6.37	0.77	2.37	19.95	<.001
Mixed-strategy version	5.07	1.30	1.07	7.58	<.001

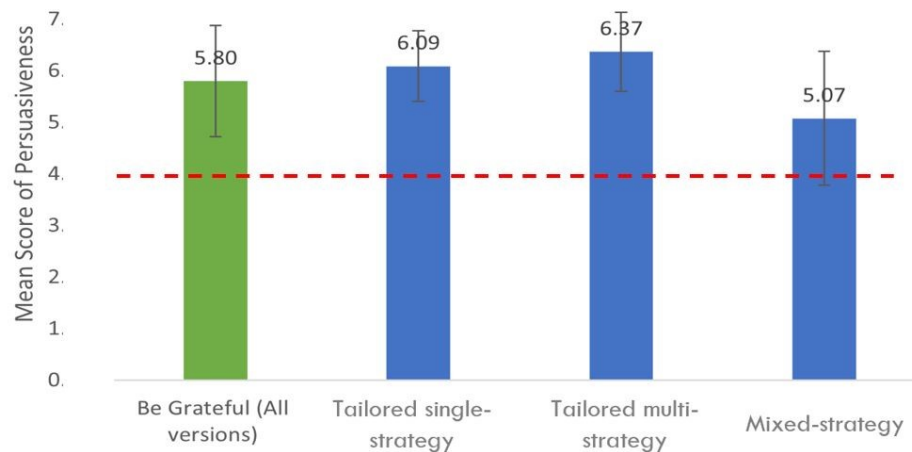


Figure 9.5 The mean score for the persuasiveness of each version of Be Grateful app as well as the overall of Be Grateful app

### **9.3 Effects of Tailoring Using Single Strategy on Mental Health Behaviour, Mental Health, Users Experience and Perceived Persuasiveness of Be Grateful app.**

In this section, I answer the following questions:

RQ3: Does Tailored single-strategy group show more positive changes in mental health behaviour compared to a Contra-tailored single-strategy group and -control group-single?

RQ4: Does Tailored single-strategy group show more improvement in mental health and emotional well-being compared to a Contra-tailored single-strategy group and Control group-single?

RQ5: Does the tailored single-strategy version of Be Grateful app increase the users experience in Tailored single-strategy group compared to Contra-tailored single-strategy and Control group-single?

RQ6: Does the tailored single-strategy version of Be Grateful app increase the user's perceived persuasiveness in Tailored single-strategy group compared to Contra-tailored single-strategy group and Control group-single?

#### **9.3.1 The Effectiveness of Tailoring Using Single Strategy on Mental Health Behaviour**

To answer **RQ3**: *Does Tailored single-strategy group show positive changes in mental health behaviour compared to a Contra-tailored single-strategy group and Control group-single?* I conducted a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects factor (Time: pre, post), and groups as between-subjects factor (Groups: Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single (I randomly assigned it to this version)) on attitude, intention, and self-efficacy (Dependent variables).

Mental health behaviours are measured by users' attitude, intention, and self-efficacy towards improving mental health and emotional well-being.

Prior to examining probable differences in attitude, self-efficacy, and intention across different groups, it is required to confirm the measurement scales' internal consistency. Cronbach's alpha ( $\alpha$ ) is used to determine a scale's consistency. All values of Cronbach's alpha were higher than the threshold value of 0.7; so, I proceeded with the study. See Table 9.4.

Table 9.4 Cronbach's alpha ( $\alpha$ ) for pre and post attitude, self-efficacy, and intention for the dataset

	Attitude		Intention		Self-efficacy	
	Pre	Post	Pre	Post	Pre	Post
Cronbach's alpha ( $\alpha$ )	.82	.83	.81	.76	.84	.81

**Time (pre-test and post-test):** The results showed there was a significant main effect of time on attitude ( $F(1, 123) = 18.940, p < .001, \eta_p^2 = 0.133$ ), intention ( $F(1, 123) = 21.486, p < .001, \eta_p^2 = 0.149$ ) and self-efficacy ( $F(1, 123) = 38.569, p < .001, \eta_p^2 = 0.239$ ) overall regardless of groups. Moreover, the pairwise comparisons for the main effect of time indicate that there was a significant difference between pre and post-tests on attitude ( $p < .001$ ), intention ( $p < .001$ ), and self-efficacy ( $p < .001$ ) when all groups are considered together. Specifically, the attitude, intention, and self-efficacy measured after using Tailoring single-strategy intervention were significantly improved compared to the attitude, intention, and self-efficacy measured before using the app. This means that after using this intervention, participants reported a positive change in attitude, intention, and self-efficacy toward promoting mental health and emotional well-being overall groups.

**Groups (Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single):** The results also show that there was a significant main effect of groups on attitude, ( $F(2, 123) = 9.95, p < .001, \eta_p^2 = 0.139$ ), intention, ( $F(2, 123) = 9.371, p < .001,$

$\eta_p^2 = 0.132$ ), and self-efficacy, ( $F(2, 123) = 12.371, p < .001, \eta_p^2 = 0.170$ ). This means that the groups rated their attitude, intention, and self-efficacy differently, establishing that there were group-level differences in the ratings. The post hoc pairwise comparison shows that participants in the Tailored single-strategy group reported a statistically significant higher in attitude, intention, and self-efficacy overall, compared to the Contra-tailored single-strategy. All measures were statistically significantly different (attitude ( $p < .001$ ), intention ( $p < .001$ ), and self-efficacy ( $p < .001$ )). Moreover, participants in the Tailored single-strategy group reported a statistically significant higher in attitude and self-efficacy overall than in the Control group-single.

**Interaction between groups and time:** The results show significant interactions between groups and time for all measures-attitude ( $F(2, 123) = 4.296, p = .046, \eta_p^2 = 0.049$ ), intention, ( $F(2, 123) = 5.718, p < .004, \eta_p^2 = 0.085$ ), and self-efficacy, ( $F(2, 123) = 12.371, p < .001, \eta_p^2 = 0.170$ ), suggesting that there were significant differences between groups over time (Figure 9.6). Surprisingly, the pairwise comparison test shows that Contra-tailored single-strategy group and Control group-single showed significant positive changes on attitude ( $p < .001, p < .05$  respectively), intention ( $p < .001, p < .001$ , respectively) and self-efficacy ( $p < .001, p < .001$ , respectively) whereas Tailored single-strategy group showed no significant change in attitude ( $p = .42$ ), intention ( $p = .95$ ) and self-efficacy ( $p = .78$ ). People in the Tailored single-strategy group are extraverted and previous research found that grateful people tend to be extraverted [6]. As a result, they rated their mental health behaviour (attitude, self-efficacy, and intention) high at baseline, and there was a slight improvement in their mental health behaviour after using the intervention, as there was no more room for improvement. These results are further explained in the Discussion Chapter.

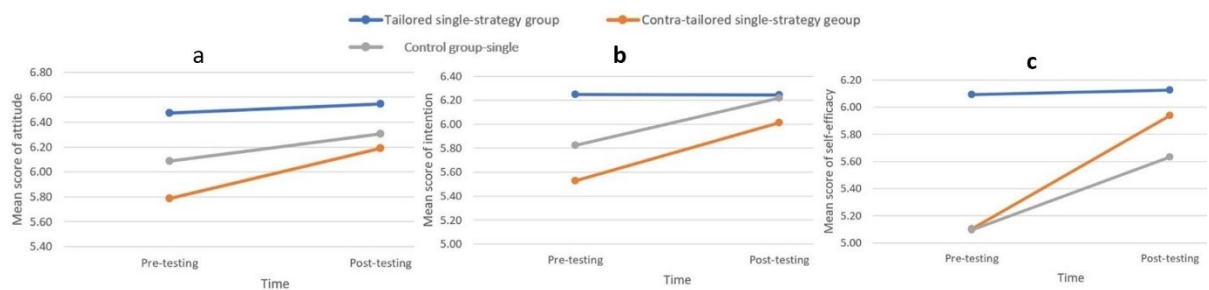


Figure 9.6 Means for attitude (a), intention (b), and self-efficacy (c) by Time and Groups

In summary, our results showed that the Tailored single-strategy group showed no significant positive changes in attitude, intention and self-efficacy toward promoting mental health and emotional well-being, thereby answering our third research question: *Does Tailored single-strategy group show positive changes in mental health behaviour compared to a Contra-tailored single-strategy group and Control group-single?* Tailored single-strategy group did not show positive changes in mental health behaviour compared to a Contra-tailored single-strategy group and Control group-single.

### **9.3.2 The Effectiveness of Tailoring Using Single Strategy on Improving Mental Health and Emotional Well-Being**

To answer **RQ4**: *Does Tailored single-strategy group show more improvement in mental health and emotional well-being compared to a Contra-tailored single-strategy group and Control group-single?* I conducted a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects factor (Time: pre, post), and groups as a between-subjects factor (Groups: Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single (I randomly assigned them to this version) on mental well-being, and perceived stress (Dependent variables).

Mental health and emotional well-being are measured by mental well-being, and perceived stress scale.

**Time (pre-test and post-test)**: The results showed there was a significant main effect of time on mental well-being ( $F(1, 123) = 55.618, p < .001, \eta_p^2 = 0.311$ ), and perceived stress ( $F(1, 123) = 59.877, p < .001, \eta_p^2 = 0.327$ ) overall regardless of groups. This means there is a significant difference between the pre-test and post-tests when all groups are considered together. Specifically, mental well-being measured after using the app was significantly improved, and perceived stress measured after using the app was significantly decreased compared to those measured before using the app. Moreover, the pairwise comparisons for the main effect of time indicate that there was a significant difference between pre and post-tests on mental well-being ( $p < .001$ ) and perceived stress ( $p < .001$ ).



This means that after using the app, participants reported increased mental well-being, and decreased perceived stress overall.

**Groups (Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single):** The results show that there was a significant main effect of groups on mental well-being ( $F(2, 123) = 10.491, p < .001, \eta_p^2 = 0.146$ ), and perceived stress ( $F(2, 123) = 4.262, p < .05, \eta_p^2 = 0.065$ ). This means that groups rated their mental well-being and perceived stress differently overall, establishing that there were group-level differences in the ratings. The pairwise comparisons for the main effect of groups indicate that the Tailored single-strategy group reported statistically significant higher mental well-being overall compared to the Contra-tailored single-strategy group ( $p < .001$ ) and Control group-single ( $p < .001$ ). Moreover, the Tailored single-strategy group reported statistically significant lower perceived stress overall compared to the Contra-tailored single-strategy group ( $p < .001$ ). However, the difference in perceived stress was not statistically significant between the Tailored single-strategy group and the Control group-single.

**Interaction between groups and time:** The results show significant interactions between groups and time on mental well-being ( $F(2,123) = 3.812, p < .05, \eta_p^2 = .058$ ), perceived stress ( $F(2,123) = 2.756, P = .05, \eta_p^2 = .043$ ) (Figure 9.7). The pairwise comparisons test showed that the mental well-being of all groups (Tailored single-strategy group ( $p < .05$ ), Contra-tailored single-strategy group ( $p < .001$ ), Control group-single ( $p < .001$ )) statistically significantly improved over time while using the app. It also showed that the perceived stress of all groups (Tailored single-strategy group ( $p < .001$ ), Contra-tailored single-strategy group ( $p < .001$ ), Control group-single ( $p < .05$ )) statistically significantly reduced over time.

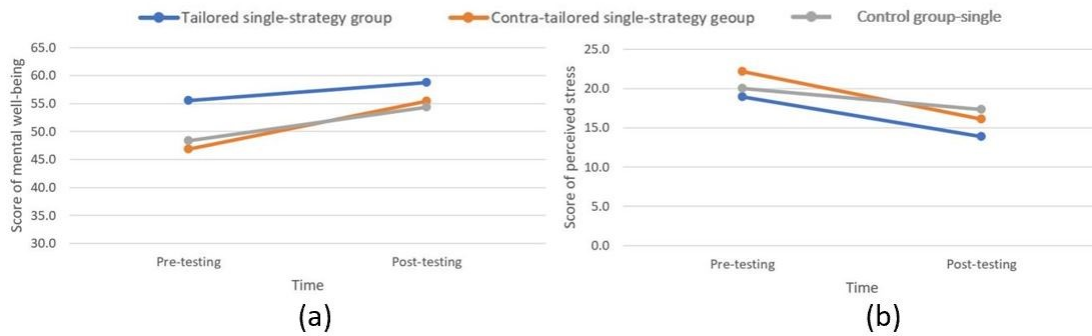


Figure 9.7 Sum score of (a) mental well-being and (b) perceived stress by Time and Groups

In summary, our results showed that the intervention is considered equally effective at promoting mental well-being and reducing perceived stress across groups – Tailored single-strategy, Contra-tailored single-strategy, and Control group-single, thereby answering our fourth research question: *Does Tailored single-strategy group show more improvement in mental health and emotional well-being compared to a Contra-tailored single-strategy group and Control group-single?* The Tailored single-strategy group did not differ from the Contra-tailored single-strategy group and Control group-single with respect to the improvement of mental health and emotional well-being.

### 9.3.3 The Effect of Tailoring Using Single Strategy on User’s Experience

To answer **RQ5**: *Does the tailored single-strategy version of Be Grateful app increase the user’s experience in the Tailored single-strategy group compared to the Contra-tailored single-strategy and Control group-single?* I conducted a one-way ANOVA with different groups (Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single) as a between-subject factor and user’s experience (interest/enjoyment, value/usefulness, effort/importance, pressure/tension, and perceived competence) as dependent measures.

**Enjoyment:** There was no significant difference in enjoyment between all groups ( $F(2,123) = 2.47, p = .089$ ). Participants in all groups enjoyed using the app version equally (Table 9.5, Figure 9.8).

**Usefulness:** There was no significant difference in the app’s usefulness between all groups as determined by one-way ANOVA ( $F(2,123) = 2.49, p = .087$ ). Participants perceived the app versions as equally useful (Table 9.5, Figure 9.8).

**Invested effort:** There was significant difference in invested effort between all groups as determined by one-way ANOVA ( $F(2,123) = 12.75, p < .001$ ). A post hoc test revealed that the Tailored single-strategy invested higher level of effort in using the app version than the Contra-tailored single-strategy group ( $p < .05$ ) and Control group-single ( $p < .001$ ) (Table 9.5, Figure 9.8).

**Tension:** there was a statistically significant difference between groups on Pressure / tension as determined by one-way ANOVA ( $F(2,123) = 12.19, p < .001$ ). A post hoc test revealed that the levels of tension after using the app were statistically significant differences between the Tailored single-strategy group ( $p = .001$ ) and the Contra-tailored single-strategy. Specifically, the Tailored single-strategy group experienced a low level of tension while using the app as compared to Contra-tailored single-strategy group. However, there was no significant difference in experienced tension between the Tailored single-strategy group and Control group-single. Therefore, participants in both groups experienced similar level of tension while using the app versions (Table 9.5, Figure 9.8).

**Perceived competence:** There was a statistically significant difference between groups on perceived competence as determined by one-way ANOVA ( $F(2,123) = 10.70, p < .001$ ). A post hoc test revealed that Tailored single-strategy group ( $p < .001$ ) led to higher feelings of competence than Contra-tailored single-strategy group. However, there was no statistically significant in the mean of perceived competence between the Tailored single-strategy group and Control group-single; suggesting that participants in both groups feel equally competent in using the app version (Table 9.5, Figure 9.8).

Table 9.5 Means (M) and Standard Deviations (SD) of IMI measures for each group

IMI measures	Groups	M	SD
Interest / Enjoyment	Tailored single-strategy group	5.93	0.93

<b>IMI measures</b>	<b>Groups</b>	<b>M</b>	<b>SD</b>
	Contra-tailored single-strategy group	5.66	0.73
	Control group-single	5.47	1.17
Value / Usefulness	Tailored single-strategy group	6.23	0.61
	Contra-tailored single-strategy group	5.90	0.65
	Control group-single	5.88	1.09
Effort / Importance	Tailored single-strategy group	5.13	0.99
	Contra-tailored single-strategy group	4.32	1.26
	Control group-single	3.93	1.31
Pressure / Tension	Tailored single-strategy group	2.51	1.06
	Contra-tailored single-strategy group	3.43	1.24
	Control group-single	2.22	1.20
Perceived Competence	Tailored single-strategy group	6.12	0.85
	Contra-tailored single-strategy group	5.22	0.96
	Control group-single	5.72	0.85

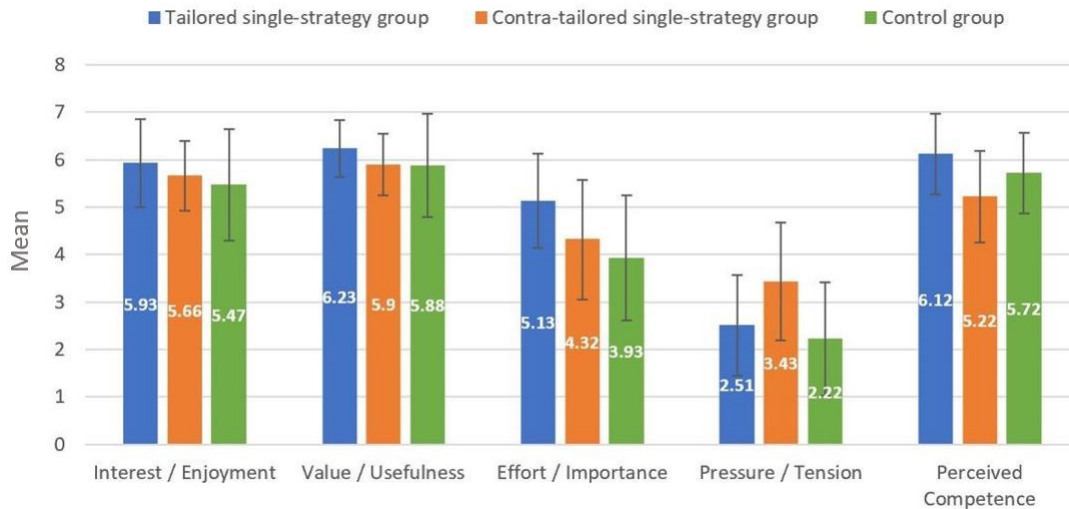


Figure 9.8 Mean of Individual IMI subscale. By groups. Error bars represent a 95% confidence interval

In summary, the results show that participants in all groups (Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single) enjoyed and perceived the usefulness of using the app version. However, the Tailored single-strategy group experienced a low level of tension and higher feelings of competence during using the app compared to Contra-tailored single-strategy group. Moreover, the Tailored single-strategy group invested more effort in using the app than Contra-tailored single-strategy group and the Control group-single (See Table 9.5 and Figure 9.8). thereby answering our fifth research question *Does the tailored single strategy version of Be Grateful app increase the users experience in Tailored single-strategy group compared to Contra-tailored single-strategy group and Control group-single group?* The tailored single-strategy version of Be Grateful app significantly improves most variables of user experience in the Tailored single-strategy group compared to the Contra-tailored single-strategy group.

### 9.3.4 Effects of Tailoring Using Single Strategy on User’s Perceived

#### Persuasiveness

To answer RQ6: *Does the tailored single-strategy version of Be Grateful app increase the user’s perceived persuasiveness in Tailored single-strategy group compared to Contra-*

*tailored single-strategy and Control group-single?* I conducted a one-way ANOVA with different groups (Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single) as between-subject factors and persuasiveness value as dependent measure.

Even though the Tailored single-strategy group show higher mean score the app’s persuasiveness compared to Contra-tailored single-strategy group and Control group-single (Table 9.6 and Figure 9.9), the results of one-way ANOVA showed that this difference was not statistically significant ( $F(2,123) = 1.83, p = .165$ ); suggesting that there were no overall group differences in how participants perceived persuasiveness of app version. All groups ((Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single) perceived persuasiveness of tailoring version app equally.

Table 9.6 Means (M) and Standard Deviations (SD) of persuasiveness for each group

Groups	M	SD
Tailored single-strategy group	6.25	0.58
Contra-tailored single-strategy group	6.02	0.51
Control group-single	6.00	0.89

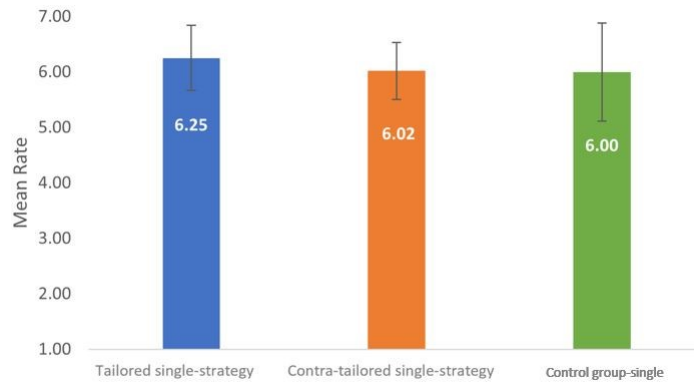


Figure 9.9 the mean of the persuasiveness of the tailored single-strategy by different groups (Tailored single-strategy group, Contra-tailored single-strategy group, Control group-single).

Error bars represent a 95% confidence interval

In summary, the results show no significant difference in the perceived persuasiveness evoked by the Tailored single-strategy group, Contra-tailored single-strategy group, and Control group-single. Thereby answering our fifth research question: *Does the tailored version of Be Grateful app increase the user's perceived persuasiveness in the Tailored single-strategy group compared to the Contra-tailored single-strategy and Control group-single?* The perceived persuasiveness of the tailored version in the Tailored single-strategy group did not differ from the Contra-tailored single-strategy group and Control group-single.

#### **9.4 Comparing the Effects of Tailoring Single Strategy Versus Multiple Strategies on Mental Health Behaviour, Mental Health, Users Experience and Perceived Persuasiveness of Be Grateful app.**

In this section, I answer the following questions:

RQ7: Does using tailored multi-strategy version promote positive changes in mental health behaviour compared to a tailored single-strategy version?

RQ8: Does using tailored multi-strategy version improve mental health and emotional well-being compared to a tailored single-strategy version?

RQ9: Does using the tailored multi-strategy version increase user experience compared to the tailored single-strategy version?

RQ10: Does using the tailored multi-strategy version increase the user's perceived persuasiveness compared to the tailored single-strategy version?

##### **9.4.1 The Effectiveness of Tailoring Using Multi-Strategy on Mental Health Behaviour**

To answer **RQ7**: *Does tailored multi-strategy version promote positive changes in mental health behaviour compared to a tailored single-strategy version?* I employed a Repeated-

Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects (pre and post) factor, and an intervention type as a between-subjects factor (single-strategy version, multi-strategy version) on attitude, intention, and self-efficacy (dependent variables).

**Time (pre-test and post-test):** The results of the repeated measure ANOVA showed that there was significant main effect of time on the measures: intention ( $F(1, 82) = 4.29, p < .05, \eta_p^2 = 0.05$ ) and self-efficacy ( $F(1, 82) = 5.47, p < .05, \eta_p^2 = 0.063$ ) and attitude ( $F(1, 82) = 3.62, p = .05, \eta_p^2 = 0.042$ ) overall regardless of the intervention version. Intention, self-efficacy and attitude measured following using the app were significantly improved from that taken before using the app, pre and post. This means that after using the Be Grateful app, participants reported a significantly increased intention ( $p = .04$ ), self-efficacy ( $p = .02$ ), and attitude ( $p = .05$ ) toward improving mental health and emotional well-being, as shown by post-hoc pairwise comparison test. The app was, therefore, overall successful in promoting a positive change in attitude, intention, and self-efficacy irrespective of the versions (single-strategy and multi-strategy versions).

**Intervention type (single-strategy version and multi-strategy version):** The results showed that there was no significant main effect of the intervention type on attitude ( $F(1,82) = .623, p = .43$ ), intention ( $F(1,82) = .000, p = .999$ ), and self-efficacy ( $F(1,82) = .218, p = .64$ ). This result suggests that the random assignment of participants to the two intervention types did not yield groups that rated their attitude, intention, or self-efficacy differently overall.

**Interaction between Time and Intervention type:** The results also showed that there was a significant interaction between time and intervention type on intention ( $F(1,82) = .4588, p < .05$ ) and self-efficacy ( $F(1,82) = 3.65, p = .05$ ) (Figure 9.10). The pairwise comparison test shows that using multi-strategy intervention led to significant positive changes in intention ( $p = .004$ ) and self-efficacy ( $p = .004$ ) whereas using single-strategy intervention led to no significant changes in intention ( $p = .96$ ) and self-efficacy ( $p = .76$ ). There was no significant interaction between time and intervention type on attitude ( $F(1,82) = .254, p = .62$ ) (Figure 9.10).



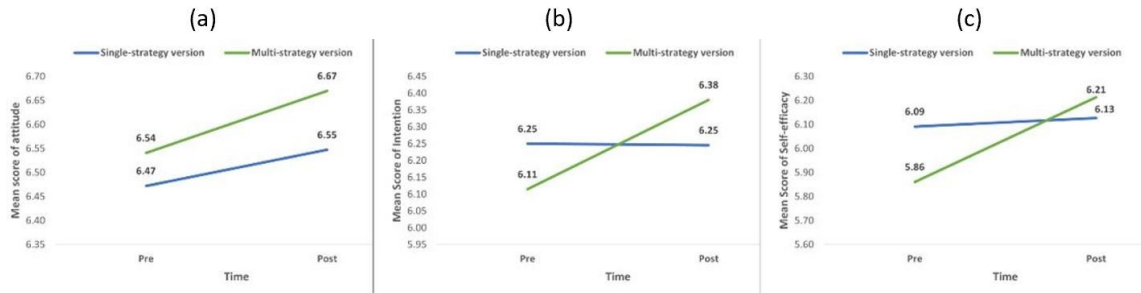


Figure 9.10 Means for (a) attitude, (b) intention, and (c) self-efficacy by Time and Intervention Type

In summary, our results showed that the tailored multi-strategy version showed significant positive changes in intention and self-efficacy toward promoting mental health, thereby answering our seventh research question: *Does tailored multi-strategy version promote positive changes in mental health behaviour compared to a tailored single-strategy version?* Implementing multiple appropriate strategies in mental health apps promote positive changes in mental health behaviour.

#### 9.4.2 The Effectiveness of Tailoring Using Multi-Strategy on Mental Health and Emotional Well-Being

To answer **RQ8**: *Does using tailored multi-strategy version improve mental health and emotional well-being compared to a Tailored single-strategy version?* I employed a Repeated- Measures Analysis of Variance (RM-ANOVA) with time as a within-subjects (pre and post) factor, and an intervention type as a between-subjects factor (single-strategy version, multi-strategy version) on mental well-being, and perceived stress (dependent variables).

**Time (pre-test and post-test):** The results of the repeated measure ANOVA showed that there was a significant main effect of time on the measures: mental health ( $F(1, 82) = 15.09, p < .001, \eta_p^2 = 0.155$ ) and perceived stress ( $F(1, 82) = 90.49, p < .001, \eta_p^2 = 0.525$ ) overall regardless of the intervention version. Mental health measured following using the app was significantly improved from that taken before using the app, and perceived stress measured following using the app was significantly reduced from that taken before using

the app, pre and post. This means that after using the Be Grateful app, participants reported significantly increased mental health ( $p < .001$ ) and significantly decreased perceived stress ( $p < .001$ ), as shown by post-hoc pairwise comparison test. The app was, therefore, overall successful in improving mental well-being and reducing perceived stress irrespective of the versions (single-strategy and multi-strategy versions).

***Intervention type (single-strategy version and multi-strategy version):*** The results showed that there was no significant main effect of the intervention type on mental well-being ( $F(1,82) = 1.073, p = .303, \eta_p^2 = .013$ ), and perceived stress ( $F(1,82) = 2.52, p = .116, \eta_p^2 = .030$ ). This result suggests that the random assignment of participants to the two intervention types did not yield groups that rated their mental health and perceived stress differently overall.

***Interaction between Time and Intervention type.*** The results also showed that there was no significant interaction between time and the intervention type on mental well-being ( $F(1,82) = .032, p = .86, \eta_p^2 = .000$ ), and perceived stress ( $F(1,82) = 2.09, p = .15, \eta_p^2 = .025$ ).

In summary, our results showed that the tailored multi-strategy version did not significantly improve mental well-being and reduce perceived stress, thereby answering our eighth research question: ***Does using a tailored multi-strategy version improve mental health and emotional well-being compared to a Tailored single-strategy version?*** Implementing multiple appropriate strategies in mental health apps did not improve mental health and emotional well-being compared to implementing a single appropriate strategy.

### **9.4.3 The Effect of Tailoring Using Multi-Strategy on User Experience**

To answer RQ9: *Does using the tailored multi-strategy version increase user experience compared to the tailored single-strategy version?* I conducted an independent sample t-test to compare the user experience evoked by the tailored single-strategy version versus the tailored multi-strategy version.

**Enjoyment:** There was no significant difference in enjoyment between multi-strategy version (M = 6.11, SD = 0.89) and single-strategy version (M = 5.93, SD = 0.93);  $t(82) = -.887, p = .038$ . Participants enjoyed both versions equally.

**Usefulness:** There was no significant difference in usefulness of the app between multi-strategy version (M = 6.31, SD = 0.76) and single-strategy version (M = 6.23, SD = 0.61);  $t(82) = -.539, p = .59$ . Participants perceived both app versions as equally useful.

**Invested effort:** There was no significant difference in invested effort between multi-strategy version (M = 4.75, SD = 1.14) and single-strategy version (M = 5.13, SD = 0.99);  $t(82) = .161, p = .11$ . Participants invested similar level of effort in using the two app versions.

**Perceived competence:** There was no significant difference in perceived competence between multi-strategy version (M = 6.00, SD = 0.83) and single-strategy version (M = 6.12, SD = 0.85);  $t(82) = .624, p = .535$ . Participants feel equally competent in using both app versions.

**Tension:** There was no significant difference in experienced tension between multi-strategy version (M = 2.54, SD = 0.91) and single-strategy version (M = 2.51, SD = 1.06);  $t(82) = -.132, p = .895$ . Participants experienced similar level of tension while using the two app versions.

In summary, One-sample t-test showed that using both the tailored multi-strategy version and a tailored single-strategy version evoked a significant positive user experience (See Table 9.7). However, the independent sample t-test shows that there is no significant difference in the user experience evoked by the tailored multi-strategy version and a tailored single-strategy version thereby answering our ninth research question: ***Does using the multi-strategy version increase user experience compared to the single-strategy version?*** The multi-strategy version provided a comparable user experience to the single-strategy version (Figure 9.11).

Table 9.7 One-sample t-test of user experience of each version using IMI scale

User experience	Single-strategy version	Multi-strategy version
<i>Enjoyment</i>	t (41) = 13.5, p < .001	t (41) =14.3, p < .001
<i>Usefulness</i>	t (41) = 23.6, p < .001	t (41) =19.8, p < .001
<i>Effort</i>	t (41) = 1.6, p = .05	t (41) = 1.9, p = .05
<i>Competence</i>	t (41) = 16.2, p < .001	t (41) =15.6, p < .001
<i>Tension</i>	t (41) = -9.1, p < .001	t (41) = -10.3, p < .001

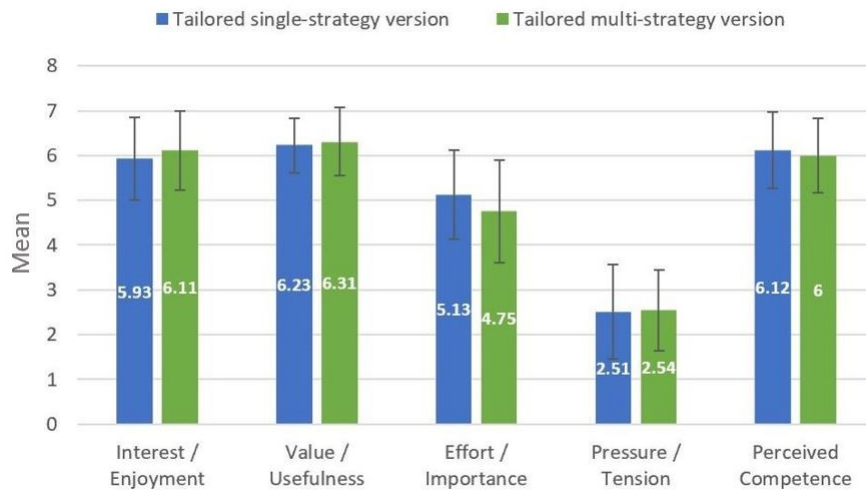


Figure 9.11 Comparing IMI measures between tailored single-strategy version, and tailored multi-strategy version

#### 9.4.4 The Effect of Tailoring Using Multi-Strategy on User’s Perceived

##### Persuasiveness

To answer **RQ10**: *Does the tailored multi-strategy version increase the user’s perceived persuasiveness compared to the tailored single-strategy version?* I conducted an independent sample t-test to compare the perceived persuasiveness evoked by the tailored single-strategy version versus the tailored multi-strategy version.

Although the mean scores of perceived persuasiveness showed that the app's persuasiveness was higher in tailored multi-strategy version than the tailored single-strategy version (Figure 9.12), the results of the independent sample t-test showed that the difference was not statistically significant ( $t(82) = -.767, p = .445$ ) between the tailored single-strategy and the tailored multi-strategy group regarding perceived persuasiveness of the app.

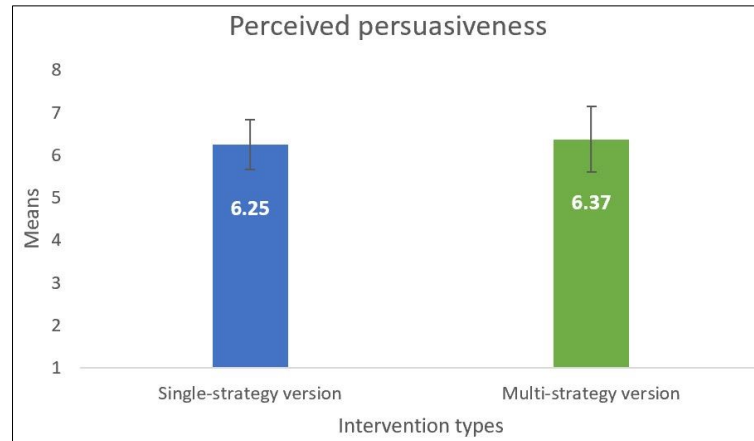


Figure 9.12 the mean of the persuasiveness of single strategy version as compared to multi-strategy version

In summary, the result of the independent sample t-test shows that there is no significant difference in the perceived persuasiveness evoked by the tailored multi-strategy version and a tailored single-strategy version thereby answering our tenth research question: ***Does the tailored multi-strategy version increase the user's perceived persuasiveness compared to the tailored single-strategy version?*** The perceived persuasiveness of multi-strategy version was a comparable to the single-strategy version. However, both the tailored multi-strategy version and the tailored single-strategy version are persuasive according to one-sample t-test, ( $t(41) = 19.95, p < .001$ ), ( $t(41) = 24.98, p < .001$ ), respectively.

## 9.5 The Effects of Mixed-Strategy version on Mental Health Behaviour, Mental Health, Users Experience and Perceived Persuasiveness of Be Grateful app

In this section, I the following research questions:

RQ11: Does using the mixed-strategy version of Be Grateful app reduce the mental health behaviour in the Mixed-strategy group compared to the Control group-mixed?

RQ12: Does using the mixed-strategy version of Be Grateful app reduce the mental health in the Mixed-strategy group compared to the Control group-mixed?

RQ13: Does using the mixed-strategy version of Be Grateful app decrease the users experience in Mixed-strategy group compared to Control group-mixed?

RQ14: Does using the mixed-strategy version of Be Grateful app decrease the user's perceived persuasiveness in Mixed-strategy group compared to Control group-mixed?

It is worth noting that the Mixed-strategy group is people who are highly open to new experiences and use the intervention that combines positive and negative strategies based on their personality types. In contrast, the Control group-mixed is like one-size-fits-all. So, their personality type and the intervention they employed are not considered.

### 9.5.1 The Effectiveness of Mixed Strategies on Mental Health Behaviour

To answer **RQ11**: *Does using the mixed-strategy version of Be Grateful app reduce the mental health behaviour of the Mixed-strategy group compared to the Control group-mixed?* I employed repeated measure-ANOVA with time as a within-subjects (pre and post) factor and groups as between-subjects (*Mixed-strategy group*, *Control group-mixed*) on attitude, intention, and self-efficacy (Dependent variables).

**Time (Pre-test, post-test)**: The results showed there was a significant main effect of time on attitude ( $F(1, 82) = 23.914, p < .001, \eta_p^2 = 0.226$ ), intention ( $F(1, 82) = 16.134, p < .001, \eta_p^2 = 0.164$ ) and self-efficacy ( $F(1, 82) = 24.102, p < .001, \eta_p^2 = 0.227$ ) overall

regardless of groups. The pairwise comparisons of the main effect of time indicate that there was a significant difference between pre and post-tests on attitude ( $p < .001$ ), intention ( $p < .001$ ), and self-efficacy ( $p < .001$ ) when all groups are considered together. Specifically, the mean scores of attitude, intention, and self-efficacy measured after using the mixed-strategy version were significantly improved compared to the mean scores of the attitude, intention and self-efficacy measured before using the app. This means that after using the app, participants reported a positive change in attitude, intention, and self-efficacy toward promoting mental health and emotional well-being overall groups.

**Groups (Mixed-strategy group, Control group-mixed):** The results also show that there was a significant main effect of groups on attitude ( $F(2, 82) = 5.85, p < .001, \eta_p^2 = 0.067$ ). This means that both groups rated their attitude differently overall, establishing that there were group-level differences in the attitude ratings. Overall, the post-hoc pairwise comparison shows that the Control group-mixed reported a statistically significant higher attitude ( $p < 0.05$ ) overall compared to the Mixed-strategy group. However, there was not a significant main effect of groups on intention, ( $F(2, 82) = 2.061, p = .16, \eta_p^2 = 0.025$ ), and self-efficacy, ( $F(2, 82) = 1.809, p < .18, \eta_p^2 = 0.022$ ).

**Interactions between groups and time:** The results show that there were no significant interactions between groups and time for attitude ( $F(2,82) = .19, p = .66, \eta_p^2 = .002$ ), intention ( $F(2,28) = .259, p = .6, \eta_p^2 = .003$ ) and self-efficacy ( $F(2,82) = .145, p = .70, \eta_p^2 = .002$ ).

In summary, the results show that *using the mixed-strategy version of Be Grateful app reduces the users' attitude overall in the Mixed-strategy group compared to the Control group-mixed*, thereby answering our 11<sup>th</sup> research question: ***Does using the mixed-strategy version of Be Grateful app reduce the mental health behaviour of the Mixed-strategy group compared to the Control group-mixed?*** Using the mixed-strategy version of Be Grateful app reduces the users' attitude overall in the Mixed-strategy group compared to the Control group-mixed.

## 9.5.2 The Effectiveness of Mixed-Strategy on Improving Mental Health and Emotional Well-Being

To answer **RQ12**: *Does using the mixed-strategy version of Be Grateful app reduce the mental health of the Mixed-strategy group compared to the Control group-mixed?* I employed repeated measure-ANOVA with time as a within-subjects (pre and post) factor, and groups as between-subjects (Mixed-strategy group, Control group-mixed) on mental well-being, and perceived stress (Dependent variables).

**Time (pre-test, post-test)**: The results showed that there was a significant main effect of time on mental well-being ( $F(1, 82) = 102.174, p < .001, \eta_p^2 = 0.56$ ), and perceived stress ( $F(1, 82) = 3.54, p = .05, \eta_p^2 = 0.041$ ) overall, regardless of groups. The pairwise comparisons showed that mental well-being ( $p < .001$ ) measured after using the mixed-strategy version of Grateful app was significantly improved compared to the measured before using the app, and perceived stress ( $p = .05$ ) was significant decreased after using the app compared to the measured before using the app. This means that after using the mixed-strategy version, participants reported increased mental well-being, and decreased perceived stress. Therefore, the app was generally successful in promoting mental well-being and decreasing perceived stress in overall groups.

**Groups (Mixed-strategy group, Control group-mixed)**: The results also showed that there was a significant main effect of group on mental well-being ( $F(2, 82) = 17.166, p < .001, \eta_p^2 = 0.173$ ), and perceived stress ( $F(2, 82) = 3.89, p = .05, \eta_p^2 = .045$ ). This means that the Mixed-Strategy group and Control group-mixed rated their mental well-being and perceived stress differently overall, establishing group-level differences in the ratings. The pairwise comparisons show that the Mixed-strategy group reported a statistically significant higher mental well-being overall than the Control group-mixed. In contrast, the Control group-mixed reported a statistically significant lower perceived stress overall than the Mixed-strategy group. All differences were significant at  $p < .05$ .

**Interactions between groups and time**: The results show significant interactions between groups and time for mental well-being ( $F(2,82) = 22.138, p < .001, \eta_p^2 = .213$ ). The pairwise



comparison test showed that mental well-being was significantly improved in both groups (Mixed-strategy group ( $p < .001$ ), Control group-mixed ( $p < .001$ ). However, there were no significant interactions between groups and time for perceived stress, ( $F(2, 28) = 12.371, p = .52, \eta_p^2 = 0.006$ ).

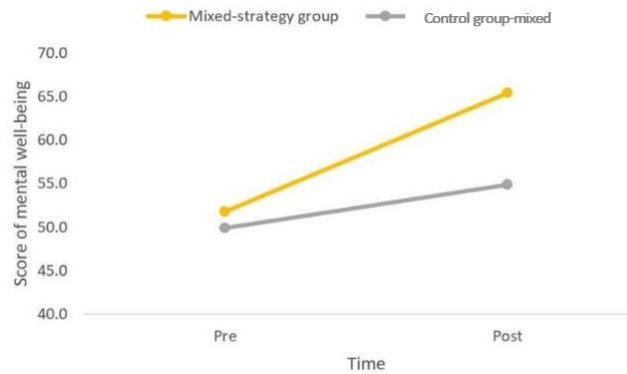


Figure 9.13 Means for mental well-being by Time and groups

In summary, the results showed that the Mixed-strategy group and Control group-mixed showed significant improvement in mental well-being while using the app, thereby answering our 12<sup>th</sup> research question: ***Does using the mixed-strategy version of Be Grateful app reduce the mental health of the Mixed-strategy group compared to the Control group-mixed?*** Using mixed-strategy version did not reduce mental well-being in the Mixed-strategy group compared to Control group-mixed.

### 9.5.3 The Effect of Mixed-Strategy Version on User’s Experience

To answer **RQ13**: *Does using the mixed-strategy version of Be Grateful app reduce the user’s experience in the Mixed-strategy group compared to the Control group-mixed?* I conducted an independent t-test to compare the user’s experience evoked by the Mixed-strategy group versus the Control group-mixed.

**Enjoyment:** There was no significant difference in enjoyment between the Mixed-strategy group ( $M = 5.37, SD = 0.57$ ) and the Control group-mixed ( $M = 5.65, SD = 1.05$ );  $t(82) = -1.555, p = .13$ . Both groups enjoyed using the mixed-strategy version equally.

**Usefulness:** There was no significant difference in the usefulness of the app between the Mixed-strategy group (M = 6.07, SD = .50) and the Control group-mixed (M = 6.13, SD = 0.90);  $t(82) = -.389, p = .7$ . Both groups perceived the app version as equally useful.

**Invested effort:** There was no significant difference in invested effort between Mixed-strategy group (M = 4.88, SD = 0.81) and Control group-mixed (M = 4.52, SD = 1.32);  $t(82) = 1.47, p = .15$ . Both groups invested similar level of effort in using the app version.

**Perceived competence:** There was a significant difference in perceived competence between the Mixed-strategy group (M = 5.33, SD = 0.54) and the Control group-mixed (M = 5.71, SD = 0.81);  $t(82) = -2.554, p < .05$ . The result suggested that perceived competence was significantly higher in Control group-mixed than the Mixed-strategy group.

**Tension:** There was a significant difference in experienced tension between the Mixed-strategy group (M = 4.05, SD = 0.91) and the Control group-mixed (M = 2.50, SD = 1.22);  $t(82) = 6.622, p < .001$ . Control group-mixed experienced lower level of tension while using the app version compared to the Mixed-strategy group.

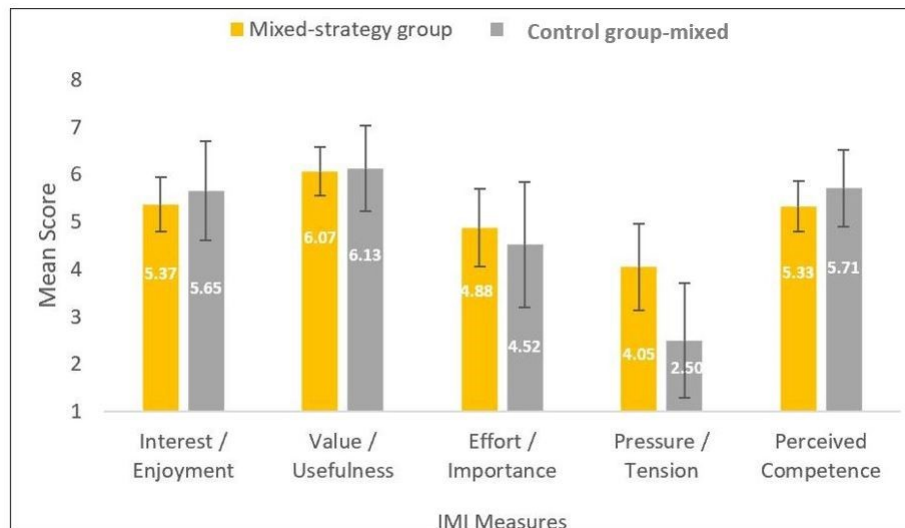


Figure 9.14 Comparing IMI measures between Mixed strategy group, and Control group-mixed

In summary, the result of the independent sample t-test shows that the Mixed-strategy group had a significantly low level of perceived competence and a high level of tension while using the app compared to the Control group-mixed; thereby answering our 13th research question: *Does using the mixed-strategy version of Be Grateful app reduces the user's experience in the Mixed-strategy group compared to the Control group-mixed?* Using a mixed-strategy version reduces the user's experience in the Mixed-strategy group compared to Control group-mixed (Figure 9.14).

#### 9.5.4 The Effect of Mixed-Strategy Version on Perceived Persuasiveness

To answer RQ14: *Does using the mixed-strategy version of Be Grateful app increase the user's perceived persuasiveness in the Mixed-strategy group compared to the -Control group-mixed?* I conducted an independent t-test to compare the users' *perceived persuasiveness* evoked by the Mixed-strategy group versus the Control group-mixed.

The results of the independent sample t-test showed that there was a statistically significant difference ( $t(82) = -10.420, p < .001$ ) between the Mixed-strategy group and the Control group-mixed; suggesting that there was a difference between the two groups regarding perceived persuasiveness. The Control group-mixed rated the app's persuasiveness higher than the Mixed-strategy group (Figure 9.15).

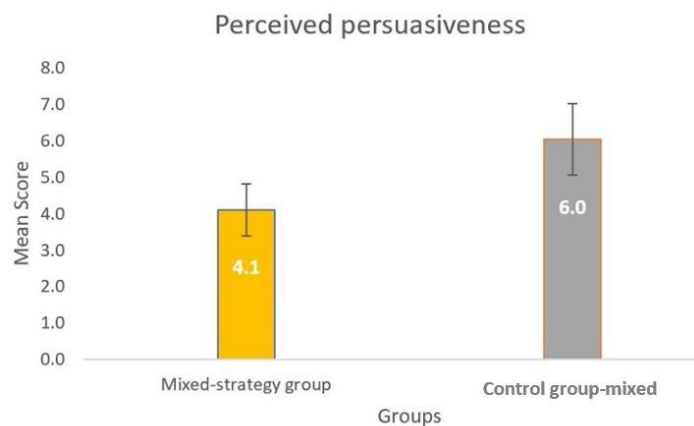


Figure 9.15 Comparing persuasiveness between Mixed strategy group, and Control group-mixed

In summary, the result of the independent sample t-test shows that the Mixed-strategy group had a significantly low level of perceived persuasiveness of the app compared to the Control group-mixed, thereby answering our 13th research question: *Does using the mixed-strategy version of Be Grateful app reduce the users' perceived persuasiveness in Mixed-strategy group compared to Control group-mixed?* The mixed-strategy version reduced the users' perceived persuasiveness in the Mixed-strategy group (Figure 9.15).

## 9.6 Thematic Analysis Results

I interviewed a total of 56 participants across the six groups (Tailored single-strategy (TS) group (N = 10), Contra-tailored single strategy (CTS) group (N = 10), Tailored multi-strategy (TM) group (N = 10), Mixed-strategy (M) group (N=10), Control group-single (CS) (N= 8), Control group-mixed (CM) (N = 8)) after the post-study survey to learn more about users' experience and their opinions about each version of the app. The interview was optional and was audio recorded with the participant's consent. The Tailored single-strategy group (TS), Contra-tailored single-strategy group (CTS) and Control group-single (CS) used the tailored single-strategy version. The Tailored multi-strategy group (TM) used the tailored multi-strategy version. Mixed-strategy group (M) and Control group-mixed (CM) used mixed-strategy version.

To preserve participants' privacy and anonymize the responses, I identified participants by acronym the group name and anonymized IDs (e.g., TS-P1, CTS-P2, CS-P3 etc.) to represent participant (1) Tailored single-strategy group (TS), (2) Contra-tailored single-strategy group (CTS) and (3) Control group-single (CS), respectively.

Overall, to better comprehend the app's effectiveness, nine themes emerged from the interviews. The first five extracted themes represent participants' feelings and experiences, while the last four extracted themes represent participants' opinions regarding the app's design.

## 9.6.1 Participants' Feedback Regarding their Experience

The section presents the patterns in the data that were extracted from participants' feelings and experiences while using Be Grateful app. The five themes identified were: (1) increased awareness of everyday kindness, (2) increase in positive emotions and the reducing negative ones, (3) positive reframing of the situations, (4) promoted deep thinking in the positive moments, and (5) suggested act of kindness as a driving force to be kind. The following subsections define each one of these themes in more detail and provide sample quotes as examples.

### 9.6.1.1 Theme 1: Increased awareness of everyday kindness

The first and most prevalent theme is **increased awareness of everyday kindness**. It refers to the increased capacity of the participants to notice and appreciate people and positive things in their life. Many participants reported that using the app increased their awareness and appreciation for everything they should be grateful for. They reported that taking time to reflect on the positive aspects of their life helped them realize how much they took for granted and things that were constantly present. The following are some examples of their responses that were extracted from the data which supports this theme:

*“The app opens my eyes to many things that I am supposed to be grateful for”* [TS-P3].

*“Being someone that was getting tired of everything, including life, the app helped me look into things that I thought didn't matter and be grateful for them”* [CTS-P7].

*“I found the app to be an eye-opening experience to the things I previously ignored”* [M-P3].

Moreover, expressing gratitude via the app helped participants to see life differently and refocus on the positive aspects of their lives rather than what was lacking or what went wrong, as some participants started. Below are some selected quotes when participants reflected on the various aspects of their life events:

*“When I started writing down things, I'm grateful for, I began to see life differently”* [TM-P9].

*“It made me look at the big picture as I have been only focusing on what’s missing rather than what I have” [CS-P2].*

*“Before using the app, I used to focus on everything that bothered me, but with the app, I know I need to remind myself what I am grateful for that day which helps me to focus on good things” [CM-P3].*

Apart from the gratitude increasing the participant’s awareness of the good things in their lives, sharing gratitude with other participants in the social community in the app also increases their awareness of things and people they should be thankful for. Some quotes regarding this aspect are below.

*“Social community is a great deal for me in the app. I get to read what others are grateful for, and when I feel like complaining, I see there's much more to be grateful for” [TM-P6].*

*“I liked the social community. I love reading other people's gratitude there and serve as a guide for me to be grateful for things I take for granted” [M-P8].*

*“I also enjoyed sharing my gratitude with others in the social community and reading others’ because it reminded me about the thing I have, and I never thought to be grateful for” [CM-P8].*

Moreover, Participants liked to share their gratitude in the social community in the app so others could recognize that life is worth being thankful for. They also enjoyed reading about others’ gratitude because it encouraged them to be grateful, which served as a daily inspiration.

*“I also like the part of the community where I would be asked if I would like to post it to the community for others to see so that they would also know that this life is worth being grateful for” [TM-P1].*

*“The community makes me aware of what others are grateful for, which also keeps me going daily” [TM-P5].*

Indeed, expressing gratitude via the app increased participants' perception of everyday kindness by appreciating the people and things around them. Moreover, allowing users in

the tailored multi-strategy and mixed-strategy versions to share their gratitude with other participants and read other posted gratitude increased this awareness and inspired them to be grateful.

### **9.6.1.2 Theme 2: Increase in positive emotions and the reduction of negative ones**

The second theme which typified the effectiveness of the app is the **increase in positive emotions and the reducing negative ones**. This theme refers to the presence of affirmative emotions like feeling happy, calm, and optimistic and the absence of negative emotions such as stress, anger, and anxiety during using the app. According to the participants, affirmative emotions were felt while reflecting on the positive aspect via the app because the app helped them to remember these moments.

For example, one participant said that *“I enjoy the app. It **helps me remember what makes me happy and maintain my emotional well-being**”* [TS-P4].

While another participant said: *“The app **helped me to be happy and optimistic**”* [M-P4].

One more participant felt that: *“My overall and emotional well-being was affected by the app in a way that I'm praying for the developer of the app because **I'm now a calm person and I'm able to think very well**”* [TS-P3].

Collectively, this suggests that the app was helpful for affirming emotions.

Moreover, using the app helped reduce participants' stress, anxiety, and anger, and improved their ability to cope with life as participants started below.

*“The app affects my overall mental health and emotional well-being by the aid to relate well, being in the normal state of mind, **reducing my anger and anxiousness**”* [TC-P9].

*“Thinking of and counting the things I am grateful for has **definitely reduced my levels of anxiety and made me cope better with life**”* [CS-P4].

*“It reduces my nervousness and serves as stress-free medicine for my body, soul and mind. It cools my mind anytime I log into the app”* [TM-P6].

*“The app is **shortening my anxiety and anger** and also making me optimistic about the future” [TM-P3].*

Thus, expressing what participants were grateful for via the app not only helped them to notice the good things, as mentioned in the previous theme but also increased positive emotions, reduced negative emotions, and enhanced their ability to cope with life.

### **9.6.1.3 Theme 3: Positive reframing of the situations**

**Positive reframing of the situations** emerged as the third theme. This theme refers to the participants' capacity to reframe their perspectives on undesirable situations and emphasize positive rationale. Participants were able to maintain self-control by not responding immediately to the acts of others and reconsidering the correct response to anything. They also were able to highlight the good aspect of a difficult day. Below are some of the specific responses.

*“The app helps me **control myself, and I don't react quickly to people's actions nowadays; instead, I would just reason very well before reacting**” [TM-P7].*

*“There was a day I wanted to react to something negatively when I remembered that I needed to be grateful and rethink before reacting to anything. If I say I'm grateful, even for this app, I will also say I'm grateful for its impact on my daily activities” [TM-P10].*

*“The app affects my overall mental health and emotional well-being by **reducing my wrong perception about other people or things**” [TM-P1].*

*“The app makes me think of **rightful answers to every question, makes me kinder and more generous among my peers**” [TS-P6].*

*“The app really helped my mental and emotional well-being to **be positive even when things seem somehow bad. I still have to be grateful**” [M-P1].*

*“I started to look at the good thing in my day. I saw a big difference in how I think and **became more positive in any situation I am in. Even if it was a busy or stressful day**” [CM-P4].*



This reaction indicates that the app changed how people perceive their surroundings. Participants were able to create memories that could be used to reframe any negative emotions or undesirable situations.

#### **9.6.1.4 Theme 4: Promoted deep thinking in positive moments**

Another theme that emerged to explain why our app affected users' mental health is **promoted deep thinking in the positive moments**. This theme refers to the app's ability to prompt users to engage in in-depth reflection on their blessings. Some participants reported that the reminder notification gave them the opportunity to reflect on something for which they are grateful, even when they were feeling unhappy. For example,

*"The reminder is good in the sense that even when I feel down and sees it, it makes me think deep down and find something to be grateful for"* [CM-P5].

*"The reminder helped me every day to be active and take a moment to think about what I am grateful for"* [CM-P7].

*"The reminder in the app gave me that moment to stop and think of the blessings around me "*[CM-P5].

Apart from that, the reminder notification assisted participants in taking a moment in their busiest life and thinking deeply about the good things they had. The previous gratitude notification also helped them to have a moment to think deeply about their previous gratitude and motivated them to be grateful. The following are some of their responses.

*"I think it makes me think deeply about my previous gratitude as a means of telling me that today again is another new day that I must be grateful for"* [TS-P8].

*"When I was reminded of my previous gratitude, what came to my mind was that I'm alive, hale and hearty, which made me think that my present moment is worth being grateful"* [TM-P6].

*"I enjoyed the daily take a deep thought of gratitude notification because I could relate to the things I posted"* [CS-P3].

However, some participants expressed that receiving notifications was the least interesting feature, and sometimes it could have been more annoying, as participant mentioned below.

*“I do not know. It only reminds me to use the app. **Nothing interesting about it**” [M-P1].*

*“I do not like the reminder. **It annoyed me**” [M-P8].*

*“**One thing that was annoying to me was that sometimes it sent me a notification for the things that I wrote in the journal yesterday. It did that repeatedly sometimes**” [CTS-P2].*

Although the notifications helped participants to have a moment to think of the good things they had and gave them hope for the future, this feature was perceived negatively by some participants in the Mixed-strategy group and contra-tailored single-strategy group.

#### **9.6.1.5 Theme 5: Suggested act of kindness as a driving force to be kind**

The fifth theme from the transcripts is the **suggested act of kindness as a driving force to be kind**. This theme drives from the shared feelings of the participants to have the desire and capability to be kind to others. According to the participants, performing acts of kindness for others made them happy and inspired them to be kind to others. In addition, the encouragement quotes along with the suggested kindness activities served as motivators for participants to be kind.

*“I enjoyed the feature of using daily suggestion notifications because **helping others makes me happy. I did go out of my way to assist a friend and make someone smile**” [TS-P1].*

*“Acts of kindness **encourage me to be kind** because I may not know the current situation someone might be in, but if I show any act of kindness to that kind of person, he or she will feel relieved and better” [TS-P3].*

*“The notification is so good and helps. **The words encourage me to be kind to others**” [TM-P5].*

*“**Reading the quotes encouraged me to be kind and motivated me to improve my attitude**” [CS-P6].*

Besides boosting users' confidence in doing some act of kindness for others, some participants in the Tailored multi-strategy group also reported that the motivational quotes

made them realize the benefit of being kind and taught them how to be kind. Here are some of their actual responses.

*“The quote reminds me of how the good act towards other people will remain positive in them and their view towards someone”* [TM-P7].

*“Daily suggestion notification encourages me to be kind in many ways because it taught me different lessons about being kind”* [TM-P2].

*“The daily suggestion notification encourages me to know the benefit I would derive from being grateful, helping others, being nice and loved by people”* [TM-P4].

In contrast, the suggested act of kindness was not a motivator for participants in the Contra-tailored single-strategy group and some participants in both Control groups. Participants did not like the suggestion notification as they perceived it as an order or a reminder to use the app. Moreover, a participant stated that suggestion notification made her feel bad about herself. Below are some examples of their responses:

*“I did not like the suggestion notification because I felt it was like an order to do something, and I did not like that”* [CS-P8].

*“The suggestions notification was the least interesting feature in the app but helped me a lot to remember the app”* [CTS-P5].

*“I think the daily suggestions and notifications can be of help in remembering to use the app”* [M-P8].

*“I did not like the suggestions because sometimes I watched the suggestion, and I was not always in a good place, and the suggestion made me feel bad about myself”* [CTS-P3].

In summary, suggested notification motivated people to be kind in Tailored single-strategy and the Tailored multi-strategy groups who perceived this strategy as a positive strategy. In contrast, it was demotivated feature for participants in Contra-tailored, Mixed-strategy groups who perceived it as a negative strategy.

The above-mentioned themes (increased awareness of everyday kindness, increase in positive emotions and the reducing negative ones, positive reframing of the situations,

promoted deep thinking in the positive moments, and suggested act of kindness as a driving force to be kind) reflect participants' experiences and feelings while using the app.

## 9.6.2 Participants' Feedback Regarding App's Design

This section presents participants' feedback regarding the app's design, usability and requested features to improve the app, which led to the identification of the following four themes: (1) impact of presenting gratitude as lily flowers, (2) appreciation for calendar visualization, (3) usability of the app, and (4) room for improvement. The following subsections define each one of these themes in more detail and provide sample quotes as examples.

### 9.6.2.1 Theme 1: Impact of presenting gratitude as lily flowers

The sixth theme that emerged in the interviews is the **impact of presenting gratitude as lily flowers**. This theme reflects participants' opinion and experiences regarding this feature. Many participants talked about how showing a lily flower for each gratitude entry attracts their attention, suggesting that it is a successful design choice for motivating users to keep using the app. This feature intended to show users how their pond was flourishing each time they were being grateful, which motivated them to express their gratitude in the app. Participants enjoyed the lily flowers as they provided a visual representation of pleasant life blooming with thoughts of gratitude. This feature also motivated users not to miss any gratitude. Participants' comments below show that the gratitude lilies flower was successful in achieving its aim.

*“I see the gratitude pond as a happy life that's flourishing with blossom thought during gratitude expression”* [TS-P4].

*“I really liked the beauty of the lily pond. The flower represents good things that happened to me made me feel happy and encouraged me not to miss any gratitude”* [CS-P7].

*“The lily pond is a feature in the app that motivates me to write my gratitude because I don't want to miss lily”* [TM-P6].

*“I like the most lily flower pond because it feels like a gaming world. At each time I*

*express gratitude, one lily shows up which motivates me to do more” [M-P9].*

Moreover, Participants reported that using different colours in lily flowers and interacting with flowers to display stored gratitude was enjoyable. As some participants stated below:

*“The water lily aspect was enjoyable because it was full of fun. I like touching the lilies because it would display everything I'm grateful for that I have written” [TS-P5].*

*“When I clicked on any flowers, I saw something positive, which I really liked. The ability to move from one flower to another to see my gratitude is another beautiful addition to the app” [CS-P4].*

*“It looks so beautiful with different colors of the lilies bringing good experiences” [TMP3].*

*“I really so much enjoy the gratitude lilies because of the flowers. I love more of nature” [M-P1].*

However, the following participant disliked the flower's design as it is more associated with female traits.

*“I do not really like the pond feature because I feel it's unnecessary since I already have the lists of my gratitude. It doesn't really connect with me. I think it is a girl's thing. It doesn't feel masculine” [TM-P1].*

Indeed, participants enjoyed showing flowers in the pond each time they were grateful and how the stored gratitude appeared when they interacted with the flower. However, although users liked this feature, gender might impact how users perceived this feature.

### **9.6.2.2 Theme 2: Appreciation for calendar visualization**

An **appreciation for calendar visualization** is the seventh theme that emerged in the interviews and explained why visualizing feelings leads to positive outcomes for some participants. Some participants stated that the calendar enabled them to reflect on previous days and filled them with joy for the good days they had lived. Below are some participants' comments.

*“The calendar allows me to **check through my past days and know how I felt and what made me happy**” [M-P3].*

*“Calendar visualization is another arena that helps the mind. **Seeing what I’ve been grateful for over the days makes me happy for the days I lived through**” [M-P6].*

Moreover, some participants appreciated the visual representation of their emotions before and after expressing gratitude in a calendar format. Additionally, they loved being able to view the gratitude that changed their feeling by clicking on the date.

*“Visualizing the mood is **the exciting feature** as they show how thinking positively help overcome your stress, **especially when you see how you felt before and after stating what you are grateful for.**” [M-P1].*

*“I liked how presenting feeling before and after expressing gratitude in a calendar so I can see how my feeling changed over five weeks and which gratitude changed my feeling one I click on that day” [M-P5].*

*“I like how my gratitude shows up when I clicked on my emotion for some days” [M-P10].*

However, some participants reported that visualization was a less interesting feature, and it only helped to know if they missed entering gratitude for a specific day.

*“I do not like the visualization as it is irrelevant to me, and I think it is the less interesting feature” [CM-P2].*

*“The calendar only makes me know when I miss the daily gratitude” [CM-P6].*

In summary, participants in the Mixed-strategy group appreciated visualizing the feeling in calendar format and their ability to interact with it to view the stored gratitude that changed their mood. However, some participants in the Control group-mixed found this feature less interesting.

### **9.6.2.3 Theme 3: Usability of the App**

The eighth theme emerged from the interview data is **usability of the app**. Usability is an essential aspect of user experience with mental health apps, and this theme reflects users’

experiences, perceptions and opinions of the app. Many participants appreciated the app's simplicity and ease of use, and the high-quality design of the app functions as one of its most appealing aspects, as shown by the sample quotes.

*“I enjoyed the app brightness, it's functions, and simplicity”* [TS-P5].

*“I enjoyed everything concerning the app because it didn't give me any problem anytime, I was using the app”* [TS-P3].

*“I enjoyed the simplicity of the application because it's easy to navigate through and straightforward”* [CTS-P9].

*“I liked the simplicity of the app. it is not complicated. It is easy to write my gratitude”* [CS-P3].

*“The app has good qualities without any errors. The functionalities are smooth”* [TM-P1].

*“I liked how the interface was organized. It did not require any effort to be used.”* [CMP8].

Participants also liked the appearance, color, and ability to add pictures to their gratitude. They also liked editing their gratitude because it created a sense of control in them. As mentioned in the below comments.

*“I like the color of the app. it is so nice and nature”* [TS-P2]

*“I like the ability to edit my gratitude because it gives me a feeling of control”* [CTS-P3].

*“I liked the journal because it was editable, and you could edit things you've written before”* [CTS-P10].

*“I really liked the ability to add a picture to my gratitude. It added meaning to my gratitude”* [CS-P3].

*“Adding pictures to my gratitude is a nice feature in the app”* [TM-P10].

Moreover, participants appreciated how the app guided them to enter their gratitude without any effort.

*“I enjoyed a lot entering what I was grateful for the way the app introduced me to the journal feature. I just opened it, and it would say write what you are grateful for just it gave you this format”* [CTS-P3].

*“I enjoyed the initial of the app where it will help me on how to write what I'm grateful for instead of finding a way of putting it by myself” [TM-P7].*

Therefore, mental health apps should be easy to use, organized, and visually appealing and give users a sense of control to enhance user engagement, which will help improve users' mental health.

#### **9.6.2.4 Theme 4: Room for improvement**

The **room for improvement** is the last theme that emerged through the interviews, and it refers to the suggestions and recommendations users mentioned to improve the app.

One frequent suggestion was that participants said that the app should provide access to mental health professionals' support in case they need it.

*“Interaction mode with maybe a psychologist or someone who has some experience” [TS-1P2].*

*“If I can get like a platform to access a professional who can help with talk, like a psychologist. It will be great” [CTS-P5].*

Although I found some privacy concerns in my study regarding recording participants feeling and experiences with the app via audio recording, one participant suggested recording notes (gratitude) using voice notes.

*“I would prefer if voice mode were added to the daily note, so we could record our voice to add notes too” [TS-P5].*

Some other participants recommended gamifying the app and adding an option to invite someone to see their gratitude journal.

*“The app can be improved by adding more features that look like a game, which would make it more fun” [TS-P3].*

*“Maybe the app can be more motivating if its members rank based on the number of gratitude notes they have input into the app” [TS-P9].*

*“I would like to be able to invite someone to see my gratitude journal and encourage each other to do that” [CSP3].*



Participants also stated that including a success story about individuals and a music playlist in the app would make the app more appealing.

*"I think it would be more effective if the app had a story about people who succeed in difficult situations"* [CM-P2].

*"The app can have a list of songs and you can choose from it, and you can upload the songs that you preferred in the app and listen to them when feeling down"* [M-P4].

While the comments mentioned above suggested adding new features to make the app more interesting, the below comments were about the suggestions to improve the existing features in the app.

Participants recommended improving the suggestion notification by receiving various suggestions, not only focusing on performing an act of kindness.

*"I would like to have a different suggestion not only doing some act of kindness but also suggest some article or positive story to read"* [C1P5].

Participants suggested some improvements in the social community by adding a profile in the app that allows them to add their information, such as pictures, interests, and hobbies, that help connect more. They also requested presenting all app users in the social community, even if they do not share gratitude, and receiving a notification when new gratitude is posted in the social community.

*"I expected profiles, especially on the social community page, to have profile pictures or a cool avatar"* [TM-P4].

*"I'd suggest that the app can have a more robust profile in terms of photos, interests, and hobbies. So, people can connect more with one another"* [TM-P6].

*"When the social community can cover everyone using the app even if they choose not to post but can still talk to one another"* [M-P2].

*"I would like to receive a sound notification when there's new gratitude shared in the community"* [TM-P1].

Moreover, participants suggested adding a sound when clicking on the water lily and showing the water lily only if the user's feeling improved after entering the gratitude.

*"The lily flower pond can make sounds when clicking on them" [M-P6].*

*"I think lilies should appear only if your feeling has improved after expressing what you're grateful for because I think this would help you think deeply about things, you should be grateful for" [CM-P1].*

The aforementioned recommendations provide sufficient information to make the Be Grateful app more robust and feature-rich.

The previous four themes (impact of presenting gratitude as lily flowers, appreciation for calendar visualization, usability of the app, and room for improvement) reflect participants' opinions regarding the app's features.

In this chapter, I presented the results from a large-scale quantitative evaluation involving 240 users and a qualitative interview involving 65 users, which allow for a more comprehensive understanding of participants' experiences. In the next chapter, I critically discuss the findings of this dissertation and the implications for persuasive mental health designers.

## CHAPTER 10: DISCUSSION

**Chapter Overview:** Previous chapter (Chapter 9) presents the results from a large-scale quantitative evaluation involving 240 users and a qualitative interview involving 65 users, which allow for a more comprehensive understanding of participants' experiences. This chapter discusses the findings of this dissertation and the implications for persuasive mental health designers.

This dissertation proposed the personality-based model-driven approach for tailoring persuasive mental and emotional well-being interventions to various personality types identified by the Big Five-Factor Model (FFM) [186].

The personality-based model-driven approach was based on four major studies. In the first study, I conducted a comprehensive review of 69 technology-based mental health intervention studies. In the second study, I reviewed 103 mental health apps from app stores (App Store and Google Play Store) to identify various persuasive strategies/features employed in the design and their implementations [10]. In the third study, I conducted six focus groups with 32 participants to uncover more insight regarding mental health app features [15]. In the fourth study, I implemented 16 common features that emerged from studies 1,2 and 3 in persuasive mental health app prototypes, and conducted a large-scale study of 561 participants to evaluate their perceived effectiveness based on personality traits.[11]. The model revealed that some features/strategies were more effective for particular personality traits, thus, providing guidelines for tailoring persuasive mental health and emotional well-being interventions to various personality traits.

To establish the feasibility of the proposed personality-based model-driven approach, I designed and evaluated three versions (tailored single-strategy, tailored multi-strategy and mixed-strategy) of mental health app called "*Be Grateful*" to encourage mental health behaviour and improve mental health and emotional well-being. The evaluation of the three versions – presented in the Chapter 9.

In this chapter, I present summary findings based on the main goals of this dissertation and highlight the key benefits of using the personality-based model-driven approach instead of the one-size-fits-all approach. Finally, I discuss some implications of the findings in this dissertation for PT mental health designers.

### **10.1 Overall Effectiveness of Be Grateful App**

The findings indicate that, overall, the Be Grateful app successfully promoted a positive experience, which was also evident from the participants' feedback. In general, Be Grateful app was very persuasive concerning its ability to promote positive mental health behaviour and improve mental and emotional wellbeing.

Participants in each version of Be Grateful app mentioned that the app encouraged them to be happier and more optimistic because it helped them focus on the positive aspects of their lives that they had previously overlooked. The app also helped them to reframe their perspectives on undesirable situations and emphasize positive rationale. In addition, they appreciated the simplicity and well-designed nature of the app as well as how the app guided them to practice their gratitude easily. This is in line with previous studies [13], [12] which suggested that mental health app should ideally be simple and straightforward. If the app is difficult to use, users may abandon it, which would not result in behavioral change or improve their mental health and emotional well-being. This is even more important for the mental health apps to avoid adding to participants' stress. Although water lily flower feature was added to increase the enjoyment and engagement with the app based on users' feedback from a pilot evaluation and majority of the participant appreciated and found it very useful, one participant did not like it because he perceived it to be a feminine feature and unmasculine. This indicates that gender may influence the effectiveness of app features. This is consistent with findings from previous studies [164], [171] [181], showing males and females perceived the persuasiveness of strategies differently. In addition, users in each version perceived the app as persuasive. Persuasive strategies in a persuasive app motivate users to continue using the app. Notably, some participants did not accept the gift card or donated it to the study as a way of showing appreciation for participating in the

study because they found the app extremely useful and helpful for their mental health situations (See sample of their email in Appendix D).

## **10.2 The Effectiveness of Tailoring Using Single-Strategy**

Surprisingly, the results show that the Tailored single-strategy group did not show significant positive changes in mental health behaviour (indicators: attitude, intention and self-efficacy), whereas Contra-tailored single-strategy group and Control group-single showed significant positive changes in mental health behaviour. People in the tailored single-strategy group are extraverted people who tend to be grateful by nature [148] and show more forgiving and grateful characteristics [6]. According to Watkins [224], the relationship between Extroversion and gratitude is the fact that grateful people have somewhat high levels of positive affectivity. Moreover, gratitude is most closely associated with warmth and cheerfulness, which represent the positive relational aspects of extraversion, and positive emotions [231]. This explains the high value of attitude, self-efficacy, and intention toward improving mental and emotional well-being in the Tailored single-strategy group at baseline and the slight improvement in their mental health attitude, self-efficacy, and intention after using the intervention as there is not much room left for improvement.

Moreover, The WEMWBS measures the state of an individual's mental well-being. The WEMWBS average score for 2011 in England was around 51 [213], showing that extraverted people in the Tailored single-strategy group ( $M = 55.5$ ) had a higher baseline mental well-being than participants in the Contra-tailored single-strategy group ( $M = 46.8$ ) and Control group-single ( $M = 48.3$ ). Previous research has shown a strong relationship between high extraversion and psychological and emotional well-being, indicating that people with high extraversion showed higher psychological and emotional well-being [115]. Although Tailored single-strategy group showed high mental well-being at baseline, they showed significant improvement in mental well-being after using the intervention ( $M = 58.7$ ). Moreover, Contra-tailored single strategy group and Control group-single showed significant improvement in mental well-being after using the intervention (Pre- $M = 46.8$ , Post- $M = 55.5$ ), and (Pre- $M = 48.3$ , Post- $M = 45.3$ ), respectively). This might be because

practicing gratitude improved their mental well-being, as shown in previous studies [41],[95], [110].

The perceived stress scale (PSS) measures the stress level within the previous month. The high-stress score is 20 or greater, with 13 being the average [53]. The average PSS score for all groups (Tailored single-strategy group, Contra-tailored single-strategy group and Control group-single) before using the intervention was around 18.9, and 22.1 and 20, respectively, indicating that the Contra-tailored single-strategy group and Control group-single experienced high stress before using the intervention compared to Tailored single-strategy group which is still above average yet not considered high stress like in Contra-tailored single strategy group and Control group-single. However, after using the intervention, the average PSS in Tailoring single-strategy group was 13, which is considered low stress, whereas the average PSS in the Contra-tailored single strategy group and Control group-single were 16.1 and 17.3, respectively, which is still above average yet not considered high stress like before using the intervention.

Although all groups (Tailored single-strategy group, Contra-tailored single-strategy group and Control group-single) are equally perceived the app as enjoyable and useful, the Tailored single-strategy group experienced a low level of tension during using the app compared to Contra-tailored single-strategy group, and Control group-single and had higher feelings of competence than Contra-tailored single-strategy group. Moreover, the Tailored single-strategy group invested higher level of effort in using the app version than the Contra-tailored single-strategy group and Control group-single. This means that the Tailored single-strategy group had positive experience with the app compared to Contra-tailored single-strategy group and Control group-single.

According to the participants' feedback in all groups (Tailored single-strategy group, Contra-tailored single strategy group and Control group-single), the tailored single-strategy version effectively increased participants' happiness and positive mood, decreasing their stress and anxiety levels, which clarifies the rationale for improving participants' mental health and emotional well-being regardless of their personality traits.

The perceived persuasiveness of a mental health app is crucial. Surprisingly, the perceived persuasiveness of the tailored version in the Tailored single-strategy group did not differ from the Contra-tailored single-strategy group and Control group-single.

Although practicing gratitude using Be Grateful is not explicitly identified as a persuasive feature, it possesses inherent persuasive properties because it compels users to utilize the system. According to Oinas-Kukkonen and Harjuma [81], information and communication systems are never neutral and can always persuade individuals. Therefore, some features, such as writing down the gratitude and gaining water lilies flower, may not directly influence individuals to maintain their mental and emotional health. Nonetheless, it encourages them to utilize the app. Taking a moment to write their gratitude and seeing it as a flower in a pond motivated them to use the app, as evidenced by user feedback.

*“I enjoyed the gratitude Lily the most. It helps to illustrate how beautiful my life will be if I am thankful” [TCS-P4].*

*“At each time I counted the flower in the pond, it motivated me to do more” [CS-P3].*

However, I found from participants’ feedback regarding suggestion&encourgemnt strategy that the Tailored single-strategy group was effectively engaged with this strategy compared to Contra-tailored single-strategy group and Control group-single. Specifically, the Tailored single-strategy group found performing the act of kindness in suggestion&encourgemnt notification helped them to feel happy and these suggested acts of kindness inspired them to be kind. In contrast, Contra-tailored single-strategy group and Control group-single found the suggestion&encourgemnt notification served as reminder to use the app and some disliked this strategy as they perceived it as a command and sometimes, they felt bad about themselves when they received the suggestion, as evidenced by user feedback.

*“I did not like the suggestion notification because I felt it was like an order to do something, and I did not like that” [CS-P8].*

*“The suggestions notification was the least interesting feature in the app but helped me a lot to remember the app” [CTS-P5].*

*“I did not like the suggestions because sometimes I watched the suggestion, and I was not always in a good place, and the suggestion made me feel bad about myself”* [CTS-P3].

### **10.3 The Effectiveness of Tailoring Using Multi-Strategy**

Although recently, research has highlighted the important of tailoring persuasive system by using only appropriate strategies for the target audience [153], [167]. The comparative effectiveness of employing multiple appropriate strategies versus a single appropriate strategy in persuasive systems is still unknown. Previous studies demonstrate that using a single appropriate strategy in persuasive games design is effective at motivating positive behavior change [170]; however, the comparative efficacy of using multiple strategies in persuasive technology remains an open research question. Therefore, my thesis also examined the hypothesis *that tailoring persuasive mental health apps by employing multiple appropriate strategies (two strategies) increases their effectiveness at motivating desired behavior change and mental health and emotional well-being more than employing a single appropriate strategy*. To achieved this, I compared between tailored single-strategy version and tailored multi-strategy version that tailored to people with a high level of extraversion.

The results show that the multi-strategy version showed significant positive changes in intention and self-efficacy compared to the single-strategy version. However, both single-tailored and multi-tailored versions are equally effective at improving mental well-being and reducing perceived stress.

Although participants in both groups (Tailored single-strategy group, Tailored multi-strategy group) had a similar score of mental well-being (M =58.7, M=59, respectively) after using both interventions, their scores were above the average (51) [213]. Moreover, after using both interventions, the average PSS in Tailored single-strategy group was 13, and PSS in Tailored multi-strategy group was 11 which both considered low stress, unlike before using the intervention which was (M= 18.9 , M= 18, respectively). Therefore, there is no significant differences between both intervention regarding improving mental well-being and reducing perceived stress after using the interventions.



Our findings also demonstrate that both single-tailored and multi-tailored versions are equally effective at improving user experience. The results show that user experience in each version measured by the Intrinsic Motivation Inventory (IMI) scale was significantly above the neutral value ( $p < .001$ ) except for tension which is significantly less than neutral value ( $p < .001$ ). This is a positive result because it shows that each version is straightforward, and easy to use so users were not tensed, nor did they feel pressured while using the app. This is particularly important for mental health apps ought to work to lower users' tension and stress. This was a conscious design decision for the Be Grateful app. According to the participants' feedback in both groups, participants appreciated the simplicity and high-quality design of the app, which clarifies the rationale for low value of tension and a greater sense of competence while using the app. In addition, users of both groups perceived the application to be useful and essential. This is supported by their feedback that shows that users found the app to be effective for enhancing their mental health and reducing stress and anxiety. It also increased their awareness on the positive aspects of their lives: "*The app opens my eyes to many things that I am supposed to be grateful for*" [TS-P5]. It is worth mentioning that including the social community in the tailored multi-strategy version also increased users' awareness and inspired them to be grateful. As the participant stated "*Social community is a great deal for me in the app. I get to read what others are grateful for, and when I feel like complaining, I see there's much more to be grateful for*" [TM-P6]. This can explain the increase in the effectiveness of the multi-strategy version. Based on quantitative and qualitative results, I conclude that including two appropriate strategies increased the app's effectiveness.

#### **10.4 The Effectiveness of Using Mixed-strategy Version**

Previous research suggested that combining multiple persuasive strategies can result in a diminished overall effect, particularly when one of the strategies is less effective than the others [103]. However, the examining efficacy of using mixed strategies in persuasive technology remains an open research question. Therefore, my thesis also examined the hypothesis *that employing mixed strategies (two appropriate strategies and two inappropriate strategies) decreases their effectiveness at motivating desired behavior*

*changes and mental health and emotional well-being.* To achieved this, I compared between Mixed-strategy group who used mixed-strategy version and Control group-mixed who randomly assigned to use the mixed-strategy version.

The results of evaluation mixed-strategy version with two different groups (Mixed-strategy group and Control group-mixed) show that using a combination of appropriate and inappropriate strategies (two strategies perceived as positive and other two perceived as negative) reduces the effectiveness of the app in Mixed-strategy group. Specifically, Mixed-strategy group showed significantly low positive change in attitude compared to Control group-mixed and there were no significant differences between Mixed-strategy group and Control group-mixed regarding intention and self-efficacy.

Mental well-being of both groups significant improved overtime. This might be because practicing gratitude improved their mental well-being, as shown in previous studies [41],[95], [110] irrespective of the persuasive strategies employed. Moreover, both groups had high score of mental well-being which were above the average (51) [213] after using the interventions. Moreover, after using the interventions, the average PSS in Mixed-strategy group was 20, and in Control group-mixed was 18.6 which considered high stress, like before using the intervention which was (M= 21, M= 20, respectively).

Our findings also demonstrate that although both groups found the app version enjoyable, useful, and important, using the mixed-strategy version led to increase in the tension, feeling pressured of participants on Mixed-strategy group while using the mixed-strategy version of the app and lowered their perceived competence and persuasiveness of the app's version.

Although participants in the Mixed-strategy group appreciated visualizing the feeling and their ability to interact with it, they perceived the suggested notification as a reminder to use the app, which clarified they did not engage in any suggested kindness by the app. Moreover, they did not like the reminder notification either and found it an annoying feature.

Based on quantitative and qualitative results, I conclude that two inappropriate strategies cancel the effectiveness of the two appropriate strategies, which resulted in demotivating

behaviour change (attitude), reduced perceived persuasiveness of the app and increased users' tension, feeling pressured while using the app. Moreover, it is futile to design an app with the expectation that at least one of the strategies will be suitable for motivating behaviour change in the target audience.

## **10.5 Implications for Persuasive Mental health Designers**

In this section, I discuss some of the implications of the findings from the studies conducted as part of this research work.

### **10.5.1 Designers of Mental Health Apps Can Employ Appropriate Multiple Strategies to Increase their App Effective.**

Research has shown that employing a single appropriate strategy in persuasive games can be effective [167]. However, no research has empirically compared the effectiveness of employing a single versus multiple strategies, the gap which I fill in this thesis. The results from the evaluation of the two versions of Be Grateful app, which one of them was designed using one appropriate strategy (suggestion&encouragement) and the other one designed using two appropriate strategies (suggestion&encouragement and social support) show that the multi-strategy version showed significant positive changes in intention and self-efficacy compared to the single-strategy version. However, designers of mental health apps need to be cautious when employing more than two appropriate strategies, as an overly complicated persuasive system might overwhelm the users and result in cognitive overload. Khaled et al. [109] suggested that having too many features in a persuasive system may lead to an overly complex system that causes cognitive overload on the part of the users.

### **10.5.2 Designers of Mental Health Apps Should Not Employ Mixed strategies – a Combination of Appropriate and Inappropriate Strategies**

It is common for mental health app designers to employ multiple random strategies in a mental health app. This is done with the expectation that at least one of the strategies will be appropriate for promoting positive mental health behavior in the target audience or will

cater for various types of individuals who may be present in a one-size-fits-all approach. Previous research suggested that combining multiple persuasive strategies can result in a diminished overall effect, particularly when one of the strategies is less effective than the others [103]. My results prove that those inappropriate strategies overcome the effectiveness of appropriate strategies, resulting in demotivating behaviour change, reduced perceived persuasiveness of the app and increased users' tense, feeling pressured while using the app.

### **10.5.3 Persuasive Mental Health Apps Can Be Tailored by Adapting Only the Strategies Employed**

One of the difficulties of tailoring mental health interventions is the cost — the amount of work required to design/adapt mental health apps for each user type. The success of the multi-strategy version of the *Be Grateful* app demonstrates that designers of mental health apps do not need to develop mental health interventions from scratch in order to adapt to the target audience. As evidenced by the design of *Be Grateful* app, designers can easily tailor mental health interventions by incorporating appropriate strategies into the interventions without making a significant change to the interventions. The personality-based model-driven approach provides an effective guide for tailoring mental health interventions to the personality type in order to improve the efficacy of mental health apps in achieving their intended goals. The model could assist mental health designers in determining not only which strategies to employ when designing interventions for different personality types, but also which strategies to avoid.

### **10.5.4 Designers of Mental Health Apps Could Tailor the App According to Gender**

Previous research has shown that female and male differ with regard to perceived effectiveness of persuasive strategies [164], [171] [181]. Moreover, our results show that there might be a gender impact in how participant perceived some of the app features. For example, *“I do not really like the pond feature because I feel it doesn't really connect with me. I think it is a girl's thing. It doesn't feel masculine”* [G2P1].

More importantly, this highlights the need for behavior change app designers to design their app in a way that enables feature customization and adaptation. This is increasingly becoming a requirement for technologies considering the diversity of users who may demand distinct features. Customization will enable designers to present default app with features and allow users to disable or enable more features as they wish. Beyond ensuring that users can tailor the system to suite them, customization gives users more control and a sense of agency in the system which may increase adoption. Research has argued that user-controlled adaptation (customization) could be preferred to system-controlled adaptation (personalization) because it gives a sense of personal touch and sense of freedom and control [173].

This chapter discusses the findings of this dissertation and the implications for persuasive mental health designers. The next chapter presents overall conclusions, contributions of this dissertation and identifies areas for future research.

## CHAPTER 11: CONCLUSION

Persuasive mental health applications (apps) are effective tools for promoting behavior change. However, most existing apps adopt a non-tailored approach in their design.

To contribute to research in this direction, this dissertation proposes a personality-based model-driven for tailoring persuasive mental health app to various personality types. The personality-based model-driven approach was based on four major studies. In the first study, I conducted a comprehensive review of 69 technology-based mental health intervention studies (Chapter 2) and persuasive strategies and their implementation. In the second study, I reviewed 103 mental health apps from app stores (App Store and Google play) to identify various persuasive features employed in the design and their implementations (Chapter 3). In the third study, I conducted six focus groups with 32 participants to uncover more insight regarding mental health app features (Chapter 4). In the fourth study, I implemented 16 common features that emerged from studies 1,2 and 3 in persuasive mental health app prototypes and conducted a large-scale study of 561 participants to evaluate their perceived effectiveness depending on people's personalities (Chapter 5). Through the model, I identified some variation in the perceptions of the persuasiveness of strategies depending on the user's personality types. Some strategies that are positively associated with behaviour change for some personality types are negatively associated with behaviour change for others.

To establish the feasibility of the proposed personality-based model-driven approach, I applied it in designing three versions of mental health app called " tailored single-strategy version, tailored multi-strategy version and mixed-strategy version" targeting two distinct personality types (Extraversion, Openness to experience).

Based on the model (in Chapter 5), the **tailored single-strategy version** implemented a single strategy (suggestion&encouragement strategy) that is tailored to extraverted people and at the same time, it is a contra-tailored for people who are highly open to new experience. The **tailored multi-strategy version** implemented two strategies (suggestion&encouragement and social support strategies) tailored to extraverted people. The **mixed-strategy version** implemented four strategies (suggestion& encouragement,

social support as positive strategies, self-monitoring and reminder as negative strategies for people who are highly open to new experience). All app versions were made up of the same features; the only difference between them was the persuasive strategy employed – Chapter 5.

By including the Tailored single-strategy group, Contra-tailored single-strategy group and Control group-single, I was able to examine the hypothesis *that tailoring persuasive mental health apps by employing single appropriate strategies increases their effectiveness at motivating desired behavior change and mental health and emotional well-being.*

Moreover, by including Tailored single-strategy group and the Tailored multi-strategy group, I was able to examine the hypothesis *that tailoring persuasive mental health apps by employing multiple appropriate strategies (two strategies) increases their effectiveness at motivating desired behavior change and mental health and emotional well-being more than employing a single appropriate strategy.*

Also, by including Mixed-strategy group and Control group-mixed, I was able to test the hypothesis *that employing mixed strategies (two appropriate strategies and two inappropriate strategies) decreases their effectiveness at motivating desired behavior change and mental health and emotional well-being.*

To demonstrate the importance of tailoring persuasive mental health apps using the personality-based model-driven approach, I conducted a large-scale evaluation of the three versions of Be Grateful app concerning their ability to promote positive changes in attitude, self-efficacy, intention, mental well-being, and perceived stress. Moreover, I measured user experience and perceived persuasive for each version as described in Chapter 9.

The personality-based model-driven persuasive app evaluation shows that although tailored single-strategy version was not effective compared to contra-tailored single-strategy, combining multiple preferred strategies (two strategies) in persuasive intervention design shows more positive result, an additive effect concerning promoting desired behaviour change and improving mental health than using single strategy in

persuasive intervention design. However, combining both multiple positive strategies and negative strategies results demotivating behaviour change because inappropriate strategies overcome the effectiveness of appropriate strategies. Finally, the interview data provides detailed insight into why the app was effective.

## **11.1 Contribution**

This dissertation describes the work I conducted to answer my overarching research question: *how can persuasive mental health apps be tailored to increase their effectiveness at motivating mental health behaviour change, and is there value in tailoring persuasive apps for mental health?* The dissertation made five significant contributions to the literature on PT of mental health for behaviour change.

### **11.1.1 Identified Persuasive Strategies and Their Implementation**

I identified various persuasive features employed in the design of mental health apps and their implementations by conducting a comprehensive review of 69 technology-based mental health intervention studies and reviewing 103 mental health apps from the App Store and Google Play.

### **11.1.2 Explored the Preferences, Needs, and Concerns of Mental Health App Users**

I conducted six focus groups with 32 participants to uncover more insight about mental health app design. Focus group study contributes to advancing state-of-the-art mental health apps by exploring the preferences, needs, and concerns of mental health app users. It also sheds light on opportunities for future work in this area by offering recommendations for designing mental health apps that meet the unique needs of this population.



### **11.1.3 Developed Models for Tailoring Persuasive Strategies to Various personality types**

I conducted cross-validation of the persuasiveness of 16 commonly employed PT strategies and developed models demonstrating the receptivity of the personality types to the PT strategies based on a large-scale study 561 participants. I proposed a personality-based model-driven approach for tailoring a persuasive mental health app. Based on the results from the models, I highlighted the most effective strategies that were perceived as positive by personality types and the least effective strategies that were not perceived as persuasive by personality types.

Having persuasion profiles of different persuasive strategies that motivate various personality types provides a crucial methodological bridge between mental health app researchers and Persuasive Technology (PT) researchers and also between personalization researchers and PT researchers. The proposed personality-based model-driven approach for tailoring persuasive mental health apps benefits from the best practices of both app design and PT researchers.

### **11.1.4 Developed a Personality-Based Model-Driven Persuasive Mental Health App**

I designed three versions of a personality-based model persuasive mental health intervention called *tailored single-strategy version, tailored multi-strategy version and mixed-strategy version*. Be Grateful app was designed as a proof-of-concept persuasive mental health app to demonstrate the feasibility of the personality-based interventions that were informed by my model for tailoring persuasive mental health apps to personality types – Chapter 6. Be Grateful app was designed to motivate mental health behaviour by (attitude, self-efficacy, and intention toward mental health and emotional well-being), improve mental well-being and reduced perceived stress. The tailored single-strategy version was tailored to extraverted people using a single strategy (this version is a contra-tailored for Openness people) and the tailored multi-strategy version was tailored to

extraverted people using two strategies while the mixed-strategy (two positive strategies and two negative strategies) was designed for Openness people – Chapter 6.

I adapted only the persuasive strategies employed in the three versions of the gratitude interventions while keeping other design elements the same. Thus, the app's user experience is the same – only the persuasive strategies change. Through the design of Be Grateful, I show that persuasive mental health app designers do not have to design each app version from scratch to adapt it to the target audience. Tailoring can easily be achieved by incorporating appropriate PT strategies into an existing app.

### **11.1.5 Conducted a Large-scale Evaluation of the Personality-based Model**

#### **Mental Health App**

I conducted a large-scale quantitative study and interview study to gain deeper insights of using the app by different personality types. The personality-based model-driven mental health app evaluation, which was intended to test the validity of my models for tailoring persuasive mental health app to various personality types, showed that although the tailored single-strategy version was ineffective compared to the contra-tailored single-strategy, combining multiple preferred strategies (two strategies) emerged to be more effective at promoting desired behaviour change and improving mental health than using a single preferred strategy in persuasive intervention design. However, combining appropriate strategies and inappropriate strategies in an intervention resulted in an ineffective app, showing the danger of a one-size-fits-all approach that is usually based on a random selection of strategies. Finally, the interview data provides detailed insight into why the app was effective. The results from the evaluation answered the three research questions of this dissertation.

### **11.2 Limitation and Future Work**

The work in this dissertation represents a first step towards tailoring persuasive mental health apps to personality types and validating the effectiveness of various PT design strategies for different personality types. Although this dissertation showed many interesting and significant results, it also opens up many opportunities for further research.

It is possible that the persuasiveness of the mental health app is mediated by user experience and that its effectiveness is driven by enjoyment and competence. Therefore, it will be of interest for future research to examine the relationship between system persuasiveness and use experience to determine the existence of a mediating effect. Moreover, there is possible moderating effect of other known differentiating user characteristics such as gender, age, and culture. It is possible that these variables significantly interact with the users' perception of a strategy and its influence on their behaviour. As a result, finer-grain tailoring to various sub-groups within each personality type would further improve the efficacy of persuasive mental health app. In the evaluation of Be Grateful app, I included only participants who self-reported stress, low mood, depression, anxiety, panic attacks, and other forms of mental health-related issues. Therefore, our results might accordingly not be generalizable to other patient collectives. Our study shows that employing two appropriate strategies in mental health apps is effective. However, it is uncertain what the maximum number of strategies can be employed in a system before reaching a point of diminishing returns. Hence, future research should investigate the breaking point (limit) to the number of strategies that can be employed in a system. Moreover, there is a need to examine how to reduce the cognitive load that may result from implementing a large number of strategies in a system to improve its effectiveness. Finally, although, we compared the effectiveness of personality tailored and untailored versions of our app in this thesis, we did not compare the effectiveness of our app against an existing intervention. Future research can evaluate the app's efficacy by comparing it to existing interventions to examine if the personality-based model-driven approach led to an improved performance.

### 11.3 Publications

Given below is the list of published papers from this thesis and my other published works as a Lead author and co-author.

1. **Alqahtani, F., & Orji, R.** (2019, June). Usability issues in mental health applications. In Adjunct Publication of the 27th Conference on User Modeling, Adaptation and Personalization (pp. 343-348).

2. **Alqahtani, F.**, Al Khalifah, G., Oyeboode, O., & Orji, R. (2019). Apps for mental health: an evaluation of behavior change strategies and recommendations for future development. *Frontiers in artificial intelligence*, 2, 30.
3. **Alqahtani, F.**, & Orji, R. (2020). Insights from user reviews to improve mental health apps. *Health informatics journal*, 26(3), 2042-2066.
4. **Alqahtani, F.**, Winn, A., & Orji, R. (2021). Co-designing a mobile app to improve mental health and well-being: Focus group study. *JMIR formative research*, 5(2), e18172.
5. **Alqahtani, F.**, Orji, R., Riper, H., Mcclary, N., Witteman, H., & Mcgrath, P. (2022). Motivation-based approach for tailoring persuasive mental health applications. *Behaviour & Information Technology*, 1-27.
6. **Alqahtani, F.**, Meier, S., & Orji, R. (2022). Personality-based approach for tailoring persuasive mental health applications. *User Modeling and User-Adapted Interaction*, 32(3), 253-295.
7. **Alqahtani, F.**, Alslaity, A., & Orji, R. (2022). Usability Testing of a Gratitude Application for Promoting Mental Well-Being. In *International Conference on Human-Computer Interaction* (pp. 296-312). Springer, Cham.
8. Oyeboode, O., **Alqahtani, F.**, & Orji, R. (2020). Using machine learning and thematic analysis methods to evaluate mental health apps based on user reviews. *IEEE Access*, 8, 111141-111158.
9. Aldenaini, N., **Alqahtani, F.**, Orji, R., & Sampalli, S. (2020). Trends in persuasive technologies for physical activity and sedentary behavior: a systematic review. *Frontiers in artificial intelligence*, 3, 7.
10. Oyeboode, O., **Alqahtani, F.**, & Orji, R. (2022, March). Exploring for Possible Effect of Persuasive Strategy Implementation Choices: Towards Tailoring Persuasive Technologies. In *International Conference on Persuasive Technology* (pp. 145-163). Springer, Cham.

11. Alkhalifah, G., **Alqahtani**, F., & Orji, R. (2020, August). Towards Mobile Applications for Co-Monitoring Children's Health Condition. In 2020 IEEE 8th International Conference on Serious Games and Applications for Health (SeGAH) (pp. 1-8). IEEE.
12. Alqahtani, F., Subramani Iyer, R., Desai, R., Orji, R., (Submitted) Mental Health App Privacy Policies: Availability, Characteristics, and Challenges based on User Study and Reviews. In Human Behavior and Emerging Technologies journal
13. **Alqahtani**, F., & Orji, R. (submitted). Comparing the Effectiveness of Employing Single Versus Multiple Persuasive Strategy in Mental health Applications. In CHI 2023.
14. **Alqahtani**, F., Orji, R., (submitted). Why are Technology-based Interventions for Mental Health and Wellbeing Effective: State-of-the-Art and Emerging Trends. Behaviour & Information Technology

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2. Aisha Muhammad Abdullahi, Kiemute Oyibo, Rita Orji, and Abdullahi Abubakar Kawu. 2019. The Influence of Age, Gender, and Cognitive Ability on the Susceptibility to Persuasive Strategies. *Information* 10, 11: 352. <https://doi.org/10.3390/info10110352>
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## APPENDIX A. PERMISSION TO USE

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# APPENDIX B. RESEARCH ETHICS BOARD APPROVAL

## LETTER 1



**Health Sciences Research Ethics Board  
Letter of Approval**

September 30, 2019

Felwah Alqahtani  
Computer Science\Computer Science

Dear Felwah,

**REB #:** 2019-4860

**Project Title:** Designing a Mobile Application for Promoting Mental Health and Well-being in youth

**Effective Date:** September 30, 2019

**Expiry Date:** September 30, 2020

The Health Sciences Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

NOTE to researcher: When the focus groups are complete and the survey is developed, the researcher must submit an amendment to have the survey approved by the REB. The survey may not be used prior to approval.

Sincerely,



Dr. Lori Weeks, Chair

# APPENDIX C. RESEARCH ETHICS BOARD APPROVAL

## LETTER 2



**Health Sciences Research Ethics Board  
Letter of Approval**

June 29, 2021

Felwah Alqahtani  
Computer Science\Computer Science

Dear Felwah,

**REB #:** 2021-5554  
**Project Title:** Evaluating a Mobile Application for Promoting Mental Health and Well-being

**Effective Date:** June 29, 2021  
**Expiry Date:** June 29, 2022

The Health Sciences Research Ethics Board has reviewed your application for research involving humans and found the proposed research to be in accordance with the Tri-Council Policy Statement on *Ethical Conduct for Research Involving Humans*. This approval will be in effect for 12 months as indicated above. This approval is subject to the conditions listed below which constitute your on-going responsibilities with respect to the ethical conduct of this research.

*Effective March 16, 2020: Notwithstanding this approval, any research conducted during the COVID-19 public health emergency must comply with federal and provincial public health advice as well as directives from Dalhousie University (and/or other facilities or jurisdictions where the research will occur) regarding preventing the spread of COVID-19.*

Sincerely,



Dr. Lori Weeks, Chair



## APPENDIX D. SAMPLE OF THE USER'S EMAIL

I include screenshots of a sample of the user's email who did not accept the gift card as a way of appreciating the study

Greetings,

I really appreciate your gift but I don't think it would be appropriate for me to accept it.  
I liked the program so much that I feel it's part of my participation to be grateful and not accepting the reward you're giving.

And this is to inform you that I'm very thankful for you and I appreciate your excellent job in executing this survey.

Wish you good luck.

I had like to donate my gift back to support your research.

I will be available for the interview during work hours of tomorrow and Friday of this week.

Regards,

# APPENDIX E: INSTRUMENTS USED IN THE DISSERTATION

## Section1: Demographic

1. What type of mental health issue have you experienced? -----
2. What is your age?
  - 18- 24 years old
  - 25 – 34 years old
  - 35 – 44 years old
  - 45 – 54 years old
  - Over 55
3. Please choose your gender:
  - Male
  - Female
  - Other (please specify) .....
4. What is the highest level of education you have completed?
  - Less than High school
  - High School or equivalent
  - College diploma
  - Bachelor's degree
  - Master's degree
  - Doctoral degree
  - Other .....
5. Have you ever used a health application to track or manage your mental health?

yes

No

**6. Have you ever practiced a gratitude intervention?**

yes

No

For how long .....

Section 2:

**Section 2:** Attitude, Intention, and Self Efficacy was adapted from [170]

**Attitude**

Improving my mental health and emotional well-being by focusing on positive thing in my life in the next two weeks would be:								
Unimportant	1	2	3	4	5	6	7	Important
Useless	1	2	3	4	5	6	7	Useful
Worthless	1	2	3	4	5	6	7	Valuable
Unenjoyable	1	2	3	4	5	6	7	enjoyable
Harmful	1	2	3	4	5	6	7	Beneficial
Unpleasant	1	2	3	4	5	6	7	Pleasant
Bad	1	2	3	4	5	6	7	Good

**Intention**

	1- Extremely unlikely						7- Extremely likely
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I intend to avoid negative thinking during the next two weeks.	1	2	3	4	5	6	7
I intend to be positive during the next two weeks.	1	2	3	4	5	6	7
I will try to focus on positive things in my life during the next two weeks.	1	2	3	4	5	6	7
I intend to improve my mental health and emotional wellbeing focus on positive things in my life during the next two weeks.	1	2	3	4	5	6	7
I will try to improve my mental health and emotional wellbeing during the next two weeks.	1	2	3	4	5	6	7
I plan to improve my mental health and emotional wellbeing during the next two weeks.	1	2	3	4	5	6	7

**Self-Efficacy**

Please rate your level of agreement with the following statements in a 7-point scale. Choosing 1-Strongly Disagree to 7-Strongly Agree.

	1- strongly disagree						7- strongly agree
If I want, I could easily improve my mental health and emotional well-being within the next two weeks	1	2	3	4	5	6	7
Whether or not I improve my mental health and emotional well-being next week is entirely up to me							
I believe I have the ability to avoid negative thinking next week.							
I am confident that I could improve my mental health and emotional well-being within the next two weeks if I want							
I am confident that I can focus on positive things during bad days							
I am confident that I can participate in positive activities							

Section 3: PERCEIVED STRESS SCALE was adapted from [54]

	Never	Almost Never	Sometimes	Fairly Often	Very Often

1. In the last month, how often have you been upset because of something that happened unexpectedly?					
2. In the last month, how often have you felt that you were unable to control the important things in your life?					
3. In the last month, how often have you felt nervous and “stressed”?					
4. In the last month, how often have you felt confident about your ability to handle your personal problems?					
5. In the last month, how often have you felt that things were going your way?					
6. In the last month, how often have you found that you could not cope with all the things that you had to do?					
7. In the last month, how often have you been able to control irritations in your life?					
8. In the last month, how often have you felt that you were on top of things?					
9. In the last month, how often have you been angered because of things that were outside of your control?					
10. In the last month, how often have you felt difficulties were piling up so					

high that you could not overcome them?					
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**Section 4: Persuasiveness Scale** was adapted from [177]

	1-Strongly Disagree				7- Strongly Agree		
	1	2	3	4	5	6	7
This app influenced me to focus on positive things in my life.	1	2	3	4	5	6	7
This app convinced me to feel happy and think positively	1	2	3	4	5	6	7
This app is personally relevant for me.	1	2	3	4	5	6	7
This app made me reconsider my mental health and emotional well-being	1	2	3	4	5	6	7
This app would motivate me to focus on positive events in my life	1	2	3	4	5	6	7

**Section 6: IMI (Intrinsic Motivation Inventory)** [170]

Interest / Enjoyment	1-Strongly Disagree				7- Strongly Agree	
	1	2	3	4	5	6
I enjoyed using this app very much.	1	2	3	4	5	6
using this app was fun.	1	2	3	4	5	6

I would describe using this app as very interesting.	1	2	3	4	5	6
	7					
using this app was quite enjoyable.	1	2	3	4	5	6
	7					
using this app was boring activity.	1	2	3	4	5	6
	7					
<b>Value / Usefulness</b>	1	2	3	4	5	6
	7					
I believe using this app is of value to me.	1	2	3	4	5	6
	7					
I think that using this app is useful for improving the awareness in promoting mental and emotional wellbeing	1	2	3	4	5	6
	7					
I think using this app is important because it can improve my mental health and emotional well-being	1	2	3	4	5	6
	7					
I believe using this app could be beneficial to me.	1	2	3	4	5	6
	7					
I would be willing to use this app again because it has some value to me.	1	2	3	4	5	6
	7					
<b>Effort / Importance</b>						
I put a lot of effort into using this app.	1	2	3	4	5	6
	7					
I tried very hard on using this app.	1	2	3	4	5	6
	7					



It was important to me to do well at this app.	1	2	3	4	5	6
	7					
I didn't put much energy into using this app. (R)	1	2	3	4	5	6
	7					
<b>Perceived Tension</b>						
I did not feel nervous at all while using this app. (R)	1	2	3	4	5	6
	7					
I felt very tense while using this app.	1	2	3	4	5	6
	7					
I was very relaxed in using this app. (R)	1	2	3	4	5	6
	7					
I was anxious while using this app.	1	2	3	4	5	6
	7					
I felt pressured while using this app.	1	2	3	4	5	6
	7					
<b>Perceived Competence</b>						
I think I am pretty good at using this app.	1	2	3	4	5	6
	7					
After using this app for a while, I felt pretty competent.	1	2	3	4	5	6
	7					
I am satisfied with my performance at this app.	1	2	3	4	5	6
	7					
I was pretty skilled at this app.	1	2	3	4	5	6
	7					
This was an app that I couldn't use very well. (R)	1	2	3	4	5	6
	7					

**Section 7: Personality traits was adapted from [186]**

On a scale of 1 to 5, to what extent do you agree with the following statements. Please circle select the number that correspond to your response to each question.

I see myself as someone who:	1	2	3	4	5
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. is reserved.	1	2	3	4	5
2. is generally trusting.	1	2	3	4	5
3. tends to be lazy.	1	2	3	4	5
4. is relaxed, handles stress well.	1	2	3	4	5
5. has few artistic interests.	1	2	3	4	5
6. is outgoing, sociable.	1	2	3	4	5
7. tends to find fault with others.	1	2	3	4	5
8. does a thorough job.	1	2	3	4	5
9. gets nervous easily.	1	2	3	4	5
10. has an active imagination.	1	2	3	4	5

## **Interview**

- 1- Can you tell me how the app affects your overall mental health and emotional well-being?
- 2- what features of the app did you enjoy? Why
- 3- what features of the app you did not like? Why
- 4- Could you explain how the daily suggestion notification encourages you to do some act of kindness?
- 5- Could you tell me what do you think of the gratitude pond that shows a lily flower in the pond each time you express your gratitude?
- 6- what do you think when the app reminds you of your previous gratitude?
- 7- What do you think of the social community where you and others share your gratitude?
- 8- please, suggest how you would like to see the app improved. Or are there any functions you would like us to add?