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# Acceptability of Persuasive Prompts to Induce Behavioral Change in People Suffering from Depression

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**Abstract.** In recent years, there has been a growing concern regarding the increased occurrence of mental health disorders amongst the population worldwide and its debilitating effects on not only the individual suffering from it but also on the economy. Depression, being the most prevalent mental illness, urges the need to test different methodologies to try and tackle the issue. One such method is the adoption of persuasive behavioral change models in prompts for mHealth applications to assist in ‘prompting’ the user to adopt healthier behaviors. However, the acceptability of such persuasive prompts along with the selection of behavioral change models most suitable for people suffering through depression is unknown. In this work, we present the results of a cross-sectional acceptability study that tested the acceptability of persuasive prompts through two types of users: ones suffering from depression and ones without any depressive symptoms. In a study with 29 individuals without depression and 21 individuals with depression, we observed the differences between the results of both types of users and were able to show that not only were the prompts accepted by both users, but they have the potential to induce behavioral change.

**Keywords:** depression · mental health · persuasion · prompt · persuasive technology · mHealth.

## 1 Introduction

Depression is one of the most common mental disorders in the world. It is associated with impairment in daily functioning, significant losses of quality of life in patients and their relatives, loss of years due to disability, including increased mortality rates and enormous economic costs [18]. The World Health Organization (WHO) has declared that worldwide, over 300 million people belonging to different age groups suffer from depression. Studies conducted by WHO revealed that a significantly large proportion of people with mental health disorders do not receive treatment [4, 1]. These barriers to treatment exist in forms of adherence difficulties, hesitance to open up to psychologists especially in cases of face-to-face counseling, lack of awareness, high treatment costs and social stigma

that is attached to therapy [23]. Mental health patients, especially in underdeveloped countries such as Pakistan, are stigmatized in such a way that not only does it disrupt their daily functioning, but it also hinders their integration into society [16]. The aforementioned issues faced by mental health patients, who mostly tend to be similar across the globe, have led to an exponential growth in the field of Human-Computer Interaction (HCI). Through this, designers and researchers explore ways to improve access to, and engagement with, therapeutic treatment [35]. Modern-day approaches to detect and treat depression and other mental illnesses comprise of availing the benefits of pervasive technology.

Recently, some notable developments in the field have been made; ranging from self-help therapies, such as computerized Cognitive Behavioral Therapy (CBT) programs [12], to designs that supplement traditional psychotherapy programs [35]. It is important to note that these non-conventional approaches to therapy are not invented to replace psychologists but merely to provide a small boost to patients who are initially reluctant to see a therapist due to the aforementioned hesitations. Mobile-health (mHealth) possesses several advantages consisting of constant and easier access to therapy, the benefit of feasibility, impartiality of mental health resources, immediate and instant support, and anonymity [30]. It is also widely agreed upon that technology-based approaches could specifically be suitable for engaging adolescents who may be more accepting of and comfortable with using technology to seek help and treatment over traditional routes such as visiting a therapist [6]. Lastly, mHealth applications reduce the barriers of face-to-face counseling, including the stigma or “embarrassment” of discussing one’s mental health problems [15]. For these reasons, mobile health provides its users with a particularly powerful and ubiquitous platform for delivering mental health interventions. However, while mobile health applications are becoming more common, there is not enough research being done regarding the content of the applications. Hence, the primary motivation behind this study is bridging the gap between the determination of which interventions mHealth applications should contain and how they should be presented.

### 1.1 Persuasive Technology for the Improvement of Mental Health

Alteration of an individual’s lifestyle is considered to be one of the primary factors that could prevent the onset of various mental health disorders such as depression and anxiety. It is also widely acknowledged that lifestyle modification could be beneficial in reducing the present symptoms of a range of mental health disorders, including depression. Lifestyle interventions may include factors like regular exercise, improving one’s diet, getting proper sleep, and avoiding substance intake such as alcohol.

While the adoption of healthy habits became our intervention of choice, we opted for persuasive prompts as the tool of intervention. By persuasive prompts, we mean messages shown to the user on mobile application screens during the interaction between human and computer. These messages try to persuade the user to perform particular tasks or try to embed an idea into the user’s mind. Dennison, L et al. suggested that tools which monitor or track behavior alone

may be insufficient in the absence of some advice or intervention to help patients adopt behavior modifications [10]. Since our persuasive prompts are targeting people with depression, it was of the utmost importance for us to take care when developing our messages by consulting psychiatrists and using behavior change models and message diversification techniques. This allowed us to ensure a variety of choice while catering to the sensitive nature of our user group.

We mapped persuasive prompts onto two persuasive models, namely the Fogg Behavior Model (FBM) and the Theory of Reasoned Action Model (TRA). FBM shows that three elements must converge at the same moment for a behavior to occur: Motivation, Ability, and Trigger. That is, in order to perform a certain behavior, all three of the aforementioned factors should co-exist; there needs to be sufficient level of motivation, the individual must have the ability to carry out that behavior and lastly, the person should be triggered to perform that behavior [13]. When a behavior does not occur, at least one of these three elements is absent from the equation.

Theory of Reasoned Action is used to predict how individuals will behave based on their pre-existing attitudes and behavioral intentions. According to Icek Ajzen, individuals first perceive a behavior as either positive or negative combined with how the society would perceive that same behavior, before intending to engage in it [2]. An individual's decision to engage in a behavior is based on the outcomes the individual expects as a result of performing the behavior. According to the theory, the intention to perform a certain behavior precedes the actual behavior. Put simply, TRA first tries to gauge an individual's attitude and intentions before trying to persuade them to do something.

## 1.2 A Study of Acceptability Using User-Centered Design Principles

The aim of this study is to test the acceptability of persuasive prompts in inducing behavioral change in people with depression. The Acceptability model evaluates a system on four factors. The first factor is utility, which matches the needs of the user with the functionalities of the system. The second factor is usability, which is if the functionalities are utilizable. The third factor is likability, i.e., the affect of the system on the user. The fourth and final factor is cost, which includes both financial and social costs of the system [19]. When it comes to mHealth applications, McCallum et al. defined acceptability as users' subjective preferences and experiences [27]. Due to the sensitive nature of our study and the fact that it was set in a country like Pakistan where the stigma attached to depression is still very high, it was essential to first test if persuasive prompts are even accepted as an intervention for people suffering through depression based on their preferences and experiences.

The principles of User-Centered Design (UCD) would best enable us to carry an acceptability study as they are based on an explicit understanding of the user [14]. The persuasive prompts were designed keeping the user's capabilities and limitations in mind. The user's then evaluated the prompts and based on their selection, particular prompts were then incorporated in an mHealth application.

## 2 Related Works

Addressing issues like depression through technology requires a multi-disciplinary review. For this study, we have tried to cover most of the relevant aspects while reviewing the related works.

### 2.1 Effects of Lifestyle Change on Mental Health

Derman et al. sheds light on the basic lifestyle modifications which should be considered and incorporated when planning out a treatment and management program for patients with mental health issues, particularly depression. The authors opt for a holistic approach and recommend using a combination of physical training, nutritional interventions and psychosocial interventions alongside anti-depressant medications as all these components are quite essential in patient management. Evidence shows that short term psychological treatments (duration of up to 3 months) can be as effective as anti-depressant medication in mild to moderate depression. Therefore, pairing physical activity with psychological treatments (CBT for instance) can have optimal results in terms of achieving improved mental health [11].

Al-Eisa et al. establishes a relationship between physical activity and psychological factors such as insomnia, depression and attention span of an individual. Physical activity was inversely related to insomnia, mood disturbance and depression. It was observed that activity of any type and degree seemed to have positive effects on depressive symptoms. As depression and insomnia influence attention span, physical activity reduces distraction and attention shifting. [3].

A study was conducted by Chekroud et al. aimed to examine the association between exercise and mental health burden and to understand the impact of elements like type of exercise, its frequency, duration or intensity. The results showed that while keeping all other socio-economic factors constant, individuals who engaged in some sort of physical activity had about 1.5 fewer days of poor mental health in a particular month than individuals who did not [9]. Similarly, the results of a study by Meyer et al. showed that exercise had a significant impact on the participants' depressive mood 10 and 30 minutes following the exercise irrespective of the intensity. As a result, it was suggested that physical activity should be employed as a symptom management tool in order to improve depressive mood and symptoms [28].

A study by Schlarb et al. examined the prevalence of sleep disturbances and mental strain in students from two European countries, Luxembourg and Germany. Students from Germany and Luxembourg Universities reported high level of mental stress and heightened sleep disturbances, elevating to a clinical level such as anxiety issues, attention deficit/hyperactivity problems, and depressive problems. The results indicate that poor sleep quality is significantly associated with diminished mental health in students from both the countries. Schlarb et al. recommends specialized intervention programs to be introduced and implemented to enhance the students' mental and physical well being [34].

A Finnish diabetes prevention study was conducted during a 36-month randomized clinical trial to assess the effect of intervention on depressive symptoms. The treatment group received individualized counseling aimed at reducing weight and increasing physical activity. The results showed that successful implementation of lifestyle modifications, such as reduction in body weight, resulted in an even greater reduction of depressive symptoms and a positive mood change, regardless of the intensity of treatment [33].

A longitudinal study with a 5 year dietary intervention program observed changes in emotions, particularly negative emotions, among participants of a cholesterol lowering study. It was seen that the changes and improvements in diet were related to reduction in depressive symptoms, hostility/aggression and lower cholesterol levels [37].

## 2.2 Persuasive Technology as a Tool for Intervention

Along with persuasive prompts, Behavior Change Support System (BCSS) is another persuasive tool designed to bring about a desirable change in people's behaviors by providing comprehensive support through employing a combination of carefully selected and integrated software features. Two domains where BCSS is most commonly used are Health and Energy. In the health domain, people are encouraged to change their behaviors or lifestyles for the better, such as incorporating exercise into their daily routines or by eating healthier. For BCSS to be effective, there needs to exist some level of motivation to begin with. BCSS brings in the element of rehearsal as a software feature to educate users and improve their self-confidence in tackling well-being issues. Researches also incorporated email-based reminders in the system. The aim of the reminders was also to prompt participants to rehearse mindfulness and other experiential exercises included in the treatment program [17].

Chao Zang [38] conducted an experiment testing the perspective associated with an e-coaching application, BeActive!, to promote physical exercise at work. E-coaching is a persuasive mechanism aimed at encouraging sustainable positive behavioral change. The paper studies factors that could make exercise seem more appealing to its users. Choice modeling was the model employed for the study. A comparison with the Fogg Behavior Model suggested that while Fogg points out the three factors that would result in a change in behavior, it is not as simple as it seems; there exists a competing effect. When having to choose between two or more options, the change in behavior would depend on the option that is preferred at that point in time, given a specific context and the behaviors involved. Option attractiveness was tweaked through a mechanism known as choice modeling; users' decision to exercise more was dependent on whether there was a trade-off involved with respect to their productivity of the main task, and whether it was socially awkward for them to engage in that activity. An interesting insight showed how adding one extreme option (doing jumping jacks) can nudge people to perceive even a moderate activity (walking) in a positive light.

Lentferink studied the effectiveness of e-technologies in behavioral change, establishing that the impact is dependent on how well the design fits the end users' and its stakeholders' values and requirements [24]. Workers found the self-tracking mechanism to be particularly useful as it helped them gain awareness about the probable stressors as well as their current state of emotions, which ultimately helped them deal with their negative emotions. Moreover, it was observed that reminding the user in real-time about negative emotions enables the provision of just-in-time suggestions [29]. Just-in-time suggestions provide the individual with the necessary resources that allow him/her to deal with the negative emotions right at the very beginning, when it is most needed and also effective [26].

Persuasive Technology to Support Chronic Health Conditions by Zechmann [36] was a study intended to investigate the perceived effectiveness of 17 persuasive strategies. Of the lot, the ones considered to be most persuasive were personalization, reminder, commitment, self-monitoring, rewards and customization. The author also stresses upon the difference between perceived persuasiveness and individual susceptibility to persuasion.

### 2.3 User-Centered Design

It is necessary to follow the key principles of User-Centered Design (UCD) practices for designing impactful mental health applications [14]. Thus, it was very important for us to understand the existing work done in technology for mental illness, particularly depression, using UCD. The key principles of UCD include user focus, active user involvement in design, evolutionary system development, prototyping, and usability evaluation. Based on these principles a framework has been developed by researchers for persuasive healthcare systems, named as, Patient-Clinician-Designer (PCD) Framework.

The PCD framework accounts for the perspectives of all three stake holders when designing a persuasive mental health app, the patient, the clinician and the designer. The framework also helps in overcoming the challenges of designing a mental health system. It accommodates complex symptoms of mental illness, supports uncertain treatment processes, maintains a high-degree of sensitivity to the seriousness of the disease and mental stigma associated with it [26]. MONARCA, a mobile application, is built using the PCD framework and is used for monitoring patients with bi-polar disorder [7]. Similarly, prompts for inhibiting behavior change can also be designed using PCD by taking into account the perspective of the stakeholders.

Since prompt design plays a central role in the process of behavior modification and habit formation, Kuo et al. conducted a study to test different design features for habit formation and behavior change [22]. The study employed daily challenges to induce habit formation of a healthy lifestyle. In this study 139 participants were recruited for a 20 day field trial. A mobile application was used to provide daily behavioral prompts, thus, supplying users with healthy and sustainable lifestyle challenges. The study provided the following design implications for mobile phone interventions focused on habit formation:

- It is feasible to have daily prompts for behavior formation since 79.1% of the participants were in favor of daily challenges
- Daily prompts with reminders can produce positive outcomes in terms of habit formation
- Diversity and repetition of the content used in prompts matter

### 3 Methodology

A structured meta-analysis was carried out and one of the research objectives of the analysis was to analyze the need and current availability of mHealth applications for depression monitoring, awareness and behavioral intervention of depression. For this purpose, we tested a total of 100 free mHealth applications. The meta-analysis is a separate study on its own, however, observations made in the analysis were used as part of the preliminary research for the current study. We observed that a simple interface with basic user guidelines along with a more personalized user experience proves to have a high usability rating. It was seen that the number of prompts shown to the user is vital for effective intervention. Although research remains inconclusive about the ideal number of behavioral prompts to be delivered in an intervention, it is suggested that daily prompts along with reminder(s) are able to bring about significant positive outcomes [22]. With the meta-analysis, we were able to identify the potential of mHealth applications for depression along with observing a major gap in current mHealth applications in terms of the usage of specific behavioral prompts as an intervention technique. Patel et al. argues that self-tracking in itself is not sufficient, and that personalized suggestions should also be a part of the strategy as it would help bridge the gap between awareness and actual behavioral change [32].

#### 3.1 Persuasive Prompts

To create our persuasive prompts, we mapped the Fogg Behavior Model (FBM) and Theory of Reasoned Action Model (TRA) on to 10 different behaviors resulting in 20 prompts. We then further divided each of the 20 prompts into Self-Diverse and Target-Diverse messages, giving us a total of 40 prompts with 4 variations of each behavior. The 4 variations are namely FBM using Self-Diverse messages, FBM using Target-Diverse messages, TRA using Self-Diverse messages, and TRA using Target-Diverse messages.

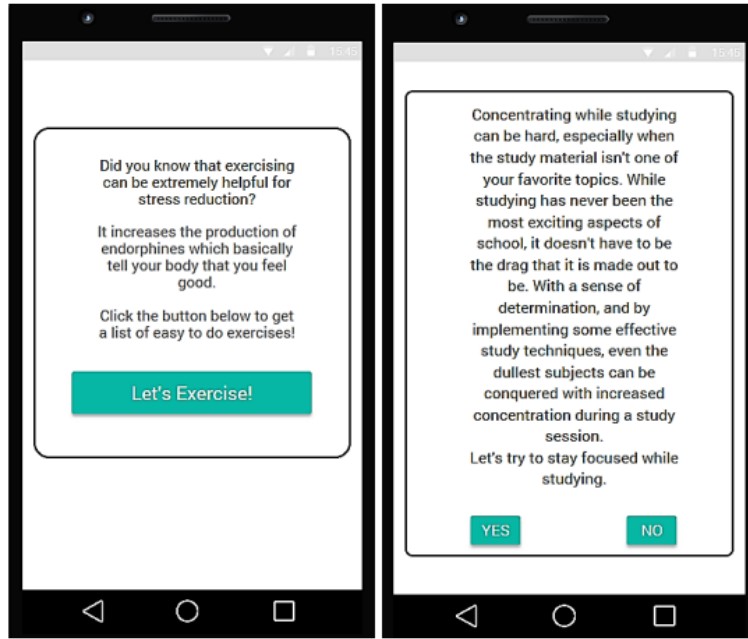
Self-Diverse(SD) and Target-Diverse(TD) are message diversification strategies [20] which we used to generate trigger messages to better understand which types of triggers would be more effective in inducing behavior change in a person with depression. SD uses concepts cognitively close to the message’s recipient while TD uses concepts cognitively close to the targeted action.

For example, a SD message would persuade the user to be more active by mentioning how exercise(target concept) can benefit the user (the self), while a TD message would focus on a specific component of the target concept, such as



walking (target action) and how it can benefit the user. SD/TD did influence the design of the persuasive prompts; they provided tools of diversification, i.e., they allowed us to make each message unique. However, the persuasive models, FBM and TRA, were the main tools in the design of the prompts. They provided the basis for the flow of the prompts along with the tone used in each message. Furthermore, text, images, audios and videos were collectively combined in the completion of the prompts.

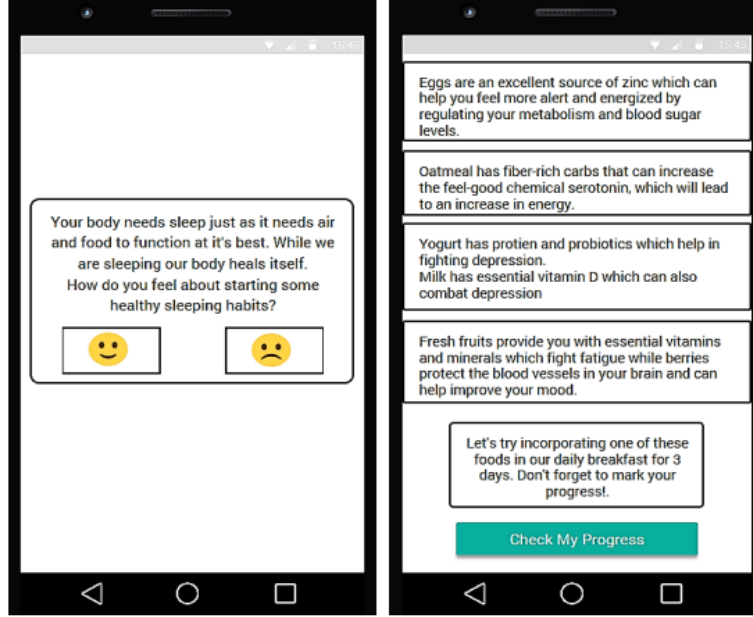
Figure 1 shows a sample of the first variation; FBM using SD messages along with with a sample of the second variation FBM using TD messages.



**Fig. 1.** Left: Sample screen of the prompt for the behavior ‘exercise’ using FBM-SD Right: Sample screen of the prompt for the behavior ‘concentration’ using FBM-TD.

The left screen is one of the screens for the prompt persuading the user to incorporate exercise in their daily routine. This particular prompt is using FBM which requires motivation, ability and trigger. The screen in the figure is handling motivation. It is establishing the idea that exercise is a good habit and has positive results giving the user a reason to exercise. Along with FBM the prompt also incorporates SD messaging by focusing on one benefit of exercising and relaying that to the user. The right screen is one of the screens for the prompts persuading the user to adopt concentration techniques when they are unable to focus. Again, this prompt is using FBM to induce the particular behavioral change by first motivating the user to do so. However, in this prompt we use TD

messaging by focusing on concentration in a particular scenario, namely studying, rather than generally discussing the benefits of concentration. We chose studying as our target behavior given that our target group was university students who spend most of their time studying. Figure 2 shows a sample of the third variation, TRA using SD messages and a sample of the fourth variation, TRA using TD messages.



**Fig. 2.** Left: Sample screen of the prompt for the behavior ‘sleep more’ using TRA-SD Right: Sample screen of the prompt for the behavior ‘eat healthy’ using TRA-TD.

The left screen is the first screen for the prompt persuading the user to start healthy sleeping habits. As this particular prompt is using TRA, we first need to know if the user perceives the behavior as positive or negative. If the user selects the happy face, implying a positive attitude, the next screen will reinforce that positive attitude and give suggestions on how they can improve their sleeping pattern. If the user selects the sad face, implying a negative attitude, the next screen will try to inverse that emotion by instilling positive aspects of the behavior. Furthermore, as we are using SD messaging, the focus of the prompt is on the benefits of sleeping. The right screen is the last screen for the prompt persuading the user to start healthy eating habits. For the TD version we chose eating breakfast as our target behavior. This screen is suggesting healthier food options that can be incorporated into an individuals daily breakfast. Furthermore, this screen will only be shown if the user has a positive attitude towards the behavior ‘eat healthy’.

**Table 1.** Major category of symptoms according to DSM-5 and ICD-10

Category	DSM-5	ICD-10
Mood		Clearly abnormal depressive mood
Interest	Markedly diminished interest or pleasure in all or almost all activities	Marked loss of interest or ability to enjoy activities that were previously pleasurable
Appetite and Weight	Significant weight loss or gain, or increase or decrease in appetite	Changes of appetite (decrease or increase), with the corresponding weight change
Sleep	Sleep problems	Sleep alterations of any kind
Psychomotor Agitation	Psychomotor agitation or retardation	Changes of psychomotor activity, with agitation or inhibition
Psychomotor Retardation	Psychomotor agitation or retardation	Changes of psychomotor activity, with agitation or inhibition
Fatigue	Fatigue or loss of energy	Lack of vitality or increase of fatigability
Guilt and Self-Esteem	Feelings of guilt, worthlessness, negative self-appraisal	Disproportionate self-reproaches and feelings of excessive guilt or inadequacy; loss of confidence and self-esteem and feelings of inferiority
Concentration	Diminished concentration or indecisiveness	Complaints about or decrease of the ability to concentrate and think, accompanied by a lack of decision and vacillation
Suicide	Recurrent thoughts of death and suicidal ideation	Recurrent thoughts of death or suicide or any suicidal behavior
Anxiety	Anxiety	Anxiety
Alcohol and Substance Use	Substance abuse	Excessive consumption of alcohol
Histrionic Behavior	Histrionic behavior	Histrionic behavior

**Choice of Behaviors:** The 10 behaviors are mapped on the major symptoms of depression as categorized by DSM-5 (Diagnostic and Statistical Manual of Mental Disorders) [5] and ICD-11 (International Statistical Classification of Diseases and Related Health Problems) [31] (Table 1). The behaviors were chosen to be the most effective in combating a majority of the major symptoms of depression. Namely, these are exercise, relax, sleep less, eat healthy, hydrate, sleep more, call someone, concentrate, self-worth and abstain from substance abuse.

### 3.2 Mobile Application-System of Intervention

A mobile e-coaching application was specifically developed for this study. The application uses persuasive prompts to persuade the user to adopt behaviors proven to improve mental health. To select the appropriate and most effective persuasive prompts, we conducted a cross-sectional study through which we obtained the preferred persuasive prompt for each behavior. These prompts were then integrated into the application. For this study, the application was simply used as a tool to present the messages (prompts). However, in the future the prompts themselves are to be part of an mHealth application, hence, the usability of the application was also tested in this study.

### 3.3 Participants and Study Design

We conducted two cross-sectional studies. 50 participants were recruited to join the first study and were divided into two groups. To obtain our sample of participants we used opportunity sampling i.e., we used people from the target population available at the time of the study and those willing to take part. All 50 participants met the recruitment criteria that they had to be students going to an educational institute of higher education between the ages of 18 and 25. Each individual was made to take a PHQ-9 test. PHQ-9 is a self-reporting tool consisting of nine questions. It is used for screening, monitoring, diagnosing, and measuring the severity of an individuals depression [21]. Group 1 (G1) included 21 participants and had the added criteria of either being clinically diagnosed as depressed or having a large number of symptoms of depression (high PHQ-9 score) as verified by a doctor. Group 2 (G2) included 29 individuals and had the added criteria of not being clinically diagnosed as depressed and showing a low number of symptoms of depression (low PHQ-9 score) as verified by a doctor. The objective of the first study was to determine which behavior change model (Fogg Behavior Model/Theory of Reasoned Action Model) was more effective in triggering behavior change in the context of depression and anxiety and to test the acceptability of the persuasive prompts. Participants from group 2 further went on to take part in the second study which was a user acceptability study of our mobile application.

Given the sensitive nature of our research, we took extra care in ensuring an ethical testing environment. Each participant was made to sign a consent form regarding their willful participation in the study along with an assurance of their privacy and anonymity. The study took place in a private setting where

the user was not afraid of unwanted visitors. Furthermore, each participant was unaware of the other participants taking part in the study as we used code names assigned to each individual rather than their real names. The testing sessions were scheduled with a substantial amount of extra time before and after each session to prevent the participants from crossing paths.

### 3.4 First Study: Persuasive Prompts

The acceptability of the persuasive prompts was tested by both group 1 and group 2. Along with the acceptability of prompts, the participants also selected which behavior change model (FBM/TRA) they preferred and which trigger mechanism (Target-Diverse/Self-Diverse) they favored to trigger the behavior change. Each behavior was divided into 4 prompts; for the scope of this study, we will only focus on the preference of the behavior change models, hence, a participant who chose the FBM-SD version of a behavior was equivalent to a participant who chose the FBM-TD version of the same behavior. Furthermore, the ten behaviors were divided into 3 categories (Figure 3) with each participant being randomly assigned one category.

Category	Total Group1 (G1) Participants	Total Group2 (G2) Participants	Behaviour	Persuasive Model	G1	G2
Category-1	7	10	Exercise	BFM	0	7
				TRA	7	3
			Sleep Less	BFM	1	7
				TRA	6	3
			Relax	BFM	1	5
				TRA	6	5
Category-2	7	10	Eat Healthy	BFM	1	10
				TRA	6	0
			Hydrate	BFM	1	10
				TRA	6	0
			Sleep More	BFM	0	7
				TRA	7	3
Category-3	7	9	Concentration	BFM	5	7
				TRA	2	2
			Calling Someone	BFM	5	8
				TRA	2	1
			Self-Worth	BFM	2	2
				TRA	5	7
			Substance Abuse	BFM	3	5
				TRA	4	4

**Fig. 3.** Figure with tabular representation of Participant Division and Preferred Model Results for each Behavior)

The categories were created in such a way that each one had a difficult behavior, a moderate behavior and an easy behavior. The difficulty level was based on the time taken to navigate through the prompts for each behavior. For group 2, ten individuals were assigned to each category 1 and 2, while nine individuals were assigned to category 3. For group 1, each category had the same number of assigned individuals, i.e, seven. For each behavior in their category, the participants scored the acceptability of the selected prompt on a Likert scale from 1-5 which contributed to our quantitative data and also, through an informal interview, further elaborated why they chose their preferred prompt; this contributed to our qualitative data [25].

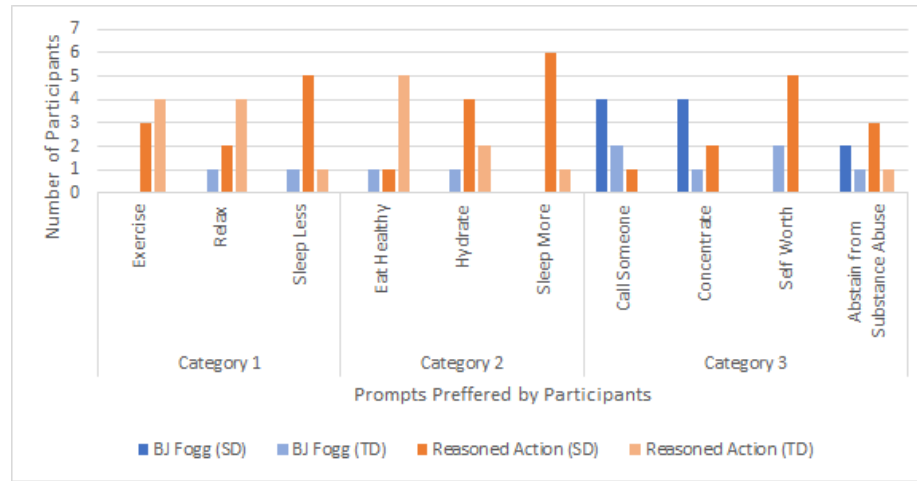
### 3.5 Second Study: Mobile Application

21 participants from group 1 further took part in the usability and acceptability of the mobile application. The final persuasive prompts selected by the participants in the first study were integrated into the application and the individuals from group 1 were again invited into a secluded lab setting to reassure confidentiality. Each participant was first given a 10 minute demonstration of the application after which they had an opportunity to test it for themselves. Each user was given two tasks: 1) Navigate to the ‘Information’ section. 2) Navigate through the prompts. While the participant was using the application, an informal conversation took place between the tester and the testee. This allowed the testee to become more comfortable in the given scenario which further resulted in vital extensive feedback which contributed to our qualitative data. After the users completed their tasks, they were given a System of Usability Scale (SUS) form to fill [8]. The SUS score contributed to our quantitative data.

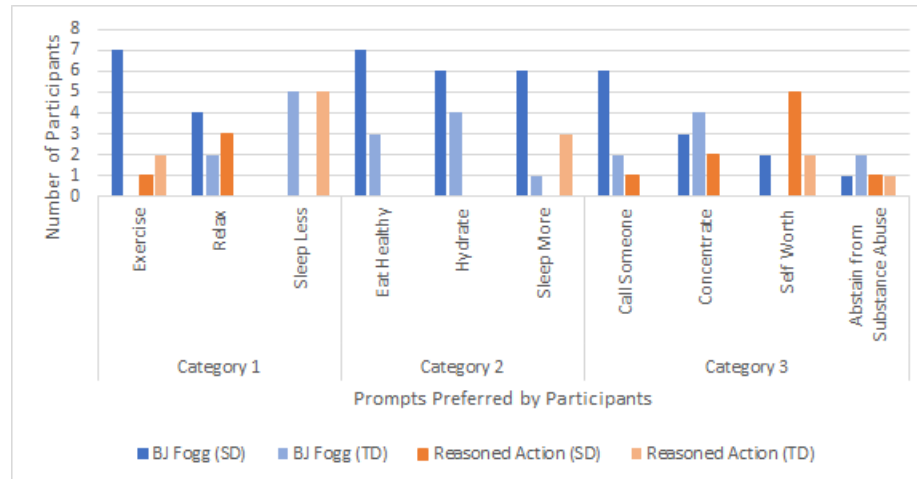
## 4 Results

### 4.1 First Study: Persuasive Prompts

Results showed a clear difference in preference for prompts between group 1 and group 2. Overall, group 2 (without depression) preferred FBM over TRA as they believed that it is more effective to be directly given a challenge rather than being asked if a challenge is desired or not. For TRA, most of the participants from group 2 felt that if an individual needs motivation to complete a task, you must motivate them without taking their preference into consideration. They claimed it was obvious the user would not be willing to do a challenge which is why they need that push that FBM offers. While on the other hand participants from group 1 (with depression) preferred TRA over FBM. They claimed that TRA takes a kinder approach by giving importance to the user’s preferences. FBM’s direct approach might appear over-burdening and even harsh when someone with depression is at a low point. The following graphs represents the behavior-wise break down of the preference of participants from group 1 and group 2 respectively:



**Fig. 4.** Prompts Preferred by Group 1 (High Depressive Symptoms)



**Fig. 5.** Prompts Preferred by Group 2 (Low or No depressive Symptoms)

A total number of 70 ratings from 21 participants of Group 1 on the Likert scale from 1-5 for all the prompts have shown a significant difference in means for the choices of FBM and TRA. The mean score for FBM is 2.94 and for TRA is 3.66 and the results are significant ( $p < 0.01$ ,  $t = -5.1884$ ). Similarly, a total number of 116 ratings from 29 participants of Group 2 on the Likert scale from 1-5 for all the prompts have shown a significant difference in means for the choices of FBM and TRA in favor of FBM. The mean score for FBM is 3.75 and for TRA is 2.54 and the results are significant ( $p < 0.01$ ,  $t = 5.02$ ).

There is a substantial difference in opinion between the participants of group 1 and group 2, which clearly shows that depression affects the perception of users about persuasion and behavior change. Participants of group 2 preferred FBM which persuades users with a direct message, straight away telling the user what to do. While group 1 preferred TRA which they found ‘friendlier’ and it provided them ‘freedom of choice’. For example, participant-13 (group 1) mentioned, regarding Relax-TRA prompt, that “It gives more of a positive energy than telling the harms of not choosing the relaxation exercise. It is not imposing and does not make you want to shut the app or throw the phone”. Similarly, another participant from group 1 stated for the self-worth-TRA prompt, “It seemed the most gentle and effective when communicating to someone who would be going through a harsh time”. One of the participants from group 1 found TRA to be more understanding and friendlier, she said, “It seems more understanding rather than bugging. It is like if you don’t want something or someone, its presence is not being imposed on you even if it is good for you like friends and family. It keeps your mood in mind and provides personal space.” Furthermore, participant-4 from group 2 said about the Exercise-TRA prompts, “It gave me the option to do as I feel at my expense. It didn’t seem offensive, didn’t make me feel bad for not working out, gave an idea of what type of exercises to do as well as how to do them.” These opinions and comments clearly indicate that when people suffer from depression, they prefer a tone that is more generous, gentle and friendly, something which TRA provided.

On the other hand, group 2 participants preferred the straight to the point prompts of FBM. For example, one of the participants from group 2 commented about their preferred prompt for Exercise and said, “It has a simpler layout, to the point and calming exercises that can be used in most situations”. Similarly, regarding the Sleep More-FBM prompt, a participant said, “It had more information and required a lesser number of clicks, more to the point than other screens and more interactive. It addressed my problem of insomnia directly”. On another instance, a participant from group 2 commented about the Hydrate-FBM Prompts, “It was interactive and to the point”.

In general, both groups unanimously thought the prompts are informative and have great potential to inhibit behavioral change in users. They found prompts helpful and encouraging, e.g., participant-19 from group 1 gave a remark about the self-worth prompt, “It comforts an individual when they’re down and when the existence of one’s own self seems pointless and he/she thinks he/she can never be good enough”. Finally, referring to the Eat Healthy Prompt, a participant stated, “I can relate the prompt to my daily routine where I usually take one kind of food more or less. This screen helped to educate me about roles played by different kinds of food in maintaining my health”.

## 4.2 Second Study: Mobile Application

19 out of 21 participants from group 1 took part in a second study where they reviewed and tested the android application. These participants were asked to



explore all the different screen flows of the application and provide feedback about its usability and acceptability.

**Usability and Acceptability of the Application** Overall participants were satisfied with the usability of the application and the average SUS score of the overall application (including prompts) was 87.9 %. According to our observation and the feedback of the participants, the design and flow of the application is user friendly. Almost all the users successfully completed all of the tasks given to them without getting stuck at any point. Only two participants found it difficult to navigate back to the main menu once they reached the last screen of one of the vertical flows. The reason for this could be that the application itself was android, while both participants were iPhone users. One of them (Participant 13) said, “I use an iPhone may be that is the reason I am unable to navigate back properly”. Participant 3 commented about the usability of the application by saying, “The design is easy to understand, and the formatting of the content is quite good.” In general, the feedback about the acceptability of the application was encouraging. All the participants said they would use the application and would also refer this application to others for use if available. They thought that the persuasive messages were conveyed through the prompts quite naturally not causing any discomfort. Participant 18 commented, “The persuasive prompts, and screening features of the application are really good, these features will help a lot in gauging the mental state of the user and also help in behavior change.”

## 5 Discussion

### 5.1 Use of Persuasive Prompts for Behavior Change Based on Persuasive Models

Persuasive models are followed by mental professionals around the world to help people understand their mental situation and adopt changes accordingly. One of the main research objectives of this study was to identify if such models can be used with technology to create awareness and induce behavior change in people suffering from depressive symptoms. The results of our study show that there is high potential in the effectiveness of persuasive prompts to induce behavior change. However, it is also important to note that constricting ourselves to one model might not be the most adequate route to take; it can clearly be seen that different people prefer different models. While our results for group 1 clearly point in the direction of TRA, a few participants did prefer FBM. For group 2, majority of the sample selected FBM; however some did lean towards TRA. Furthermore, the clear difference in both groups allows us to better understand which models have what type of effect on a mental state. People who have depression prefer the gentler TRA model, while people who do not have depression and just want to get things done prefer the more aggressive FBM. This gives us further motivation to map the effects of a large number of persuasive models against different levels of depression.

From our visits to different psychiatrists, one common theme we observed was the use of kindness and encouragement when talking to a patient suffering from depression. For someone going through depression, something as simple as remembering to drink water can be difficult. Most of our participants that were clinically diagnosed with depression informed us that they do not have the motivation to get things done making it extremely difficult to get through a day and it is not just the lack of motivation, but also lack of wanting to be motivated. The use of persuasive prompts in a mobile application provides an effective medium through which encouragement and kindness can be a constant part of an individual's routine. The main focus of persuasive behavior change models is to provide encouragement in the form of motivation and to give reminders to ease the pressure of having to constantly remember what to do. This further strengthens the importance of not just mental health applications, but applications that are using persuasive models to help their users.

**Preference of TRA by Patients with Depression:** Majority of our users that suffered through depression anonymously chose TRA as their preferred model. This is a vital contribution of our paper as it provides more insight into what factors have a larger impact in intervention for depression patients. Through qualitative analysis and user feedback we were able to reflect on why TRA was preferred. As mentioned before, the prompts based on this model were of a softer tone, keeping in account the preferences of the users. Participants felt that their input was valued but at the same time they also felt that the prompts provided the required push to motivate them. They stated that the fact that even after the 'sad face' was chosen, the prompt still didn't give up on the user, rather it gently tried to change their mind, provided motivation to try the task. As a result of this, users were ultimately able to carry out the desired task which normally they would not be able to do. Patel et al also makes a similar recommendation, the paper advises the practitioners to involve the patient extensively when planning out a treatment or intervention program for them as it would help the patient in making well informed choices with respect to their lifestyle to promote physical health and mental wellbeing [32].

**General Implications of the Study:** From the findings, we observed that there is potential for persuasive prompts to act as a viable intervention to encourage behavior change in people suffering with depression. If an individual with depressive symptoms who strongly suffers from the lack of motivation to carry out different tasks, can find the motivation to perform certain tasks assigned to them by a mobile application due to the nature of the prompts being shown, implies that the persuasive prompts have potential beyond the scope of this study. As lack of motivation is faced by individuals with and without depression, persuasive prompts can even be extended to daily use and not just be restricted to people with mental health issues. For instance, they can also be used by an individual who does not seem to have depressive symptoms, yet lacks motivation to reach the goals they have set for themselves. It is important to

note that individuals who do not generally suffer from this problem would be further encouraged by either of the models.

## 5.2 Usability and Acceptability of an mHealth Application for Depression

As mentioned before, in a country like Pakistan a lack of awareness regarding mental health has resulted in people not even knowing if they are suffering from depression or anxiety. Furthermore, the stigma attached to this topic makes it more difficult for them to accept help from any source. In such a scenario, the biggest challenge is to identify if people would accept the general idea of mental health intervention and deem it appropriate in their setting. Our study has shown that mental health interventions for behavioral change are not only acceptable but welcomed by the younger generations of Pakistan. Most participants that took part in our study felt that the application has the potential to change the behavior of the user. They also took a keen interest in the study and provided feedback on how the features and design can be enhanced further to have a better impact. Majority of the participants were also comfortable with the content used in the prompts. Participants showed no signs of anger or discomfort while using the application and encouraged the idea of such interventions. Regarding the usability of the application, the SUS score of 87.9 and the qualitative feedback clearly shows that the application was simple, well designed and easy to use.

## 6 Conclusion

In this paper, we presented the results of the acceptability of the use of persuasive prompts to encourage behavioral change in people suffering from depression. We show that the use of persuasive models in an mHealth application can influence behavioral change and such models are acceptable. Furthermore, there was a distinct preference division between both user groups with regard to the preferred model. The Theory of Reasoned Action Model was preferred by users with depression, while users not showing symptoms of depression preferred the Fogg Behavioral Model. Future directions for this work include studying the long-term effects of persuasive prompts through mHealth applications and confirm their ability to induce behavioral change.

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