Towards Encouraging a Healthier Lifestyle and Increased Physical Activity – An App Incorporating Persuasive Design Principles

Sunny Ladwa[1], Tor-Morten Grønli[2], and Gheorghita Ghinea[1,2(✉)]

[1] Brunel University, Uxbridge UB8 3PH, UK
sunnyladwa90@gmail.com, george.ghinea@brunel.ac.uk
[2] Westerdals Oslo School of Arts, Communication and Technology, Oslo, Norway
tmg@westerdals.no

Abstract. The number of young adults becoming overweight leading to obesity is on an unceasing rise. Attempts have been made to tackle this epidemic throughout the UK through varied technology platforms including video games and more recently through ubiquitous mobile applications. With a significant increase of smartphone usage, mobile applications have become the ideal platform to reach out to young adults. This paper addresses the obesity epidemic and the fundamental value of healthy living through the development of an app which encourages eating a balanced diet and particularly increasing the time spent exercising by incorporating it into an individual's daily routine. It focuses on tackling the common barriers currently preventing individuals from increasing their level of physical activity and aims to provide a solution to the problem domain by implementing persuasive design principles, models and frameworks in an android mobile application to successfully change or modify behaviors and attitudes within young adults to increase the time spent on exercise and a healthy lifestyle.

Keywords: m-Health · Obesity · Persuasive design

1 Introduction

One of the most common health concerns in the UK is related to obesity and being overweight, which results in poor quality of life, illnesses and even resulting in mortality. Obesity is a condition where a person accumulates a vast amount of body fat that negatively affects an individual's health and in which weight has been gained to the point of seriously endangering one's health. There has been a significant increase in the proportion of the UK population who are now categorized as overweight or obese, with 27% of adults classed as obese and a further 36% who are overweight, making a total of 63% who are either overweight or obese [36]. The impact of obesity is so severe that a recent study claims that being overweight can cut life expectancy between 1–10 years [20]. Consequently, failing to address the obesity epidemic will place an even greater burden on the UK's National Health Service resources with an existing cost of approximately £6.1billion in 2014–2015 alone. The annual spend is currently on an

M. Kurosu (Ed.): HCI 2018, LNCS 10902, pp. 158–172, 2018.
https://doi.org/10.1007/978-3-319-91244-8_13

upward trend and according to Public Health London, the UK-wide NHS costs attributable to overweight and obesity are projected to reach a staggering £9.7 billion by 2050, with wider costs to society estimated to reach £49.9 billion per year which will continue to rise to treat overweight and obesity related health problems [36]. Obesity is a serious health implication that in fact can easily be prevented with a balanced diet and regular exercise.

Smartphones are ubiquitous and with an increase in usage amongst young adults has led to mobile phones being considered as a necessity. A study conducted by Statista in 2017 reports that the main smartphone owners are aged 16–24 with a confounding 96% of market share [43]. This in turn has led the younger generation to use their smartphones for all their daily activities from shopping online, communicating with friends and family to playing games. The sheer popularity and ease of access to smartphones has resulted in numerous developments of mobile applications within the Mobile-Health (m-Health) division with it being the fastest-developing sector, with over 100,000 health applications (apps) currently available [13, 15, 31, 41, 42]. Furthermore, the concept of changing an individual's behavior using mobile applications has become the optimal choice to increase obesity prevention awareness, additionally, with modern features integrated into mobile phones such as GPS and pedometers; it provides the ideal platform to embolden exercise amongst young adults [12].

In order to introduce behavior change via technology, persuasive design principles are becoming increasingly common in mobile applications. B.J Fogg was the first to articulate the concept of 'Captology', a term used to describe the overlap between persuasion and computers. Fogg [11] defines persuasive technology as 'any interactive computing system designed to change people's attitudes or behaviors' and has created the Fogg Behaviour Model (FBM). This poses a question on how persuasive technology can be utilized to improve the lives of young adults through exercise and adopt a healthier lifestyle

In addressing this issue, the aim of the study reported in this paper is to gain an understanding of how persuasive design principles can be integrated in the form a modern mobile application that encourages young adults to lead healthier lifestyle and increase their motivation to exercise frequently. Accordingly, the structure of this paper is as follows: Sect. 2 details work done in respect of obesity prevention, with a particular emphasis on approaches involving Information and Communication Technologies. Section 3 then presents the main principles behind the persuasive systems design mode, whilst Sect. 4 details our contribution, namely PowerFIT, an app for obesity prevention incorporating persuasive design principles. Lastly, conclusions are drawn and opportunities for future work identified in Sect. 5.

2 Obesity and Its Prevention

Obesity amongst young adults is a key health concern due to its correlation with chronic diseases such as type-2 diabetes, cardiovascular diseases, hypertension and cancer. These in turn are primary drivers of healthcare costs, disabilities and cause a decrease in life expectancy [45]. According to a study by the Public Health England, recent estimates suggest over 62.9% of adults were overweight or obese of which

67.8% were men and 58.1% women [36]. With a large proportion of the population being classed as overweight, it is imperative to highlight the dangers of weight gain and endorse increased levels of physical activity to prevent health and lifestyle complications. Additional studies also suggest that moderate weight gain from early to middle adulthood is associated with significantly increased risk of major chronic diseases, mortality and decreased odds of healthy aging [49].

With the growing number of young adults in scope for obesity, it is vital that changes to their lifestyles are made to increase both the quality and longevity. Considerable evidence has increased over the last few decades with an emphasis on physical activity that can reduce the risk of heart disease. Longer periods of inactivity have proven to lead to not only obesity but also expose individuals to major heart diseases. Further evidence has also accumulated linking physical inactivity to an increased risk for other chronic conditions, including stroke [17], cancer [46] and non-insulin dependent diabetes [5]. It is evident that obesity has detrimental health and social implications however these findings may help counsel patients regarding the risks of weight gain along with understanding whether or not they are in fact overweight.

2.1 Preventing Obesity

It is common knowledge that a balanced diet combined with moderate exercise can prevent obesity yet this practice is often followed by few due to the lack of knowledge amongst individuals. According to a recent study on the related factors causing obesity, education levels of the subjects appeared to be the most important factor in controlling body weight [39] therefore, every effort should be made to increase the level of education on healthy nutrition and the significance of regular physical activity.

An increase in regular physical activity and healthy eating amongst adolescents must become a lifestyle choice, as opposed to dieting and unhealthy weight control behaviors, which may be counterproductive. Though dietary weight loss interventions often result in weight loss, weight maintenance on a long-term basis is the key problem in obesity treatment [1]. There are concerns that "obesity prevention efforts may also lead to the development of eating disorders" [14], as a result, it is vital to ensure that obesity prevention and treatment is conducted appropriately with a focus on a healthy lifestyle and "positive eating and physical behaviors that can be maintained on a regular basis" are encouraged [30].

In order to prevent obesity, a basic understanding on the factors causing weight gain as wellbeing perceptive as to why there has been no significant decline in the epidemic will provide a prospect to design the mobile application to ensure the existing hindrances are accounted for.

Physical activity has far-reaching benefits to individuals. There has been extensive research supporting the notion on the positive effects of exercising, including physical and psychological well-being. Anderson and his team conducted an in-depth study on how moods are affected by the level of physical activity, suggesting, "acute exercise can have beneficial effects on the mood" [3]. Studies have linked physically activity with increased happiness where recent findings revealed that individuals who are more physically active are actually happier. These individuals tend to be happier in the moments when they are more physically active [22].

However, the duration of physical activity became an important variable to consider. For instance, experiments have been conducted on individuals based on duration and intensities, the results of which showed consistently positive effects of acute exercise at low intensities, with a duration of up to 35 min for low to moderate exercise doses [38]. To complement this, research reported in [35] compared studies that measured physical activity and daily mood and concluded that light and moderate physical activities were also associated with positive daily affect, but vigorous activity was not.

Mobile applications are providing an exciting platform to develop physical activity interventions with researchers beginning to base the design of applications on established health and persuasive theories. With applications such as Pokémon Go being the most downloaded iOS app of 2016 [25] which uses local geo-location information to encourage participants to exercise, it is obvious that the broad reach of mobile applications is phenomenal and highlights how the world of ubiquitous computing can target large audiences, resulting in potential exceptional behavior changes. The application provides challenges in the form of "hatching eggs" where the user must walk a specific distance to "hatch" the egg; the challenge aspect was a considerable motivation for players.

These findings indicate how exercise plays an important role in improving ones' lifestyle and can potentially prevent obesity; therefore, exercise should be viewed as an obligation and be considered the norm in order to lead a healthy prolonged life.

2.2 Healthy Eating

Eating a healthy balanced diet along with frequent exercise is known to be beneficial for one's health and can potentially reduce the risks of obesity. Though this is common knowledge, few lead this lifestyle. To reap the benefits of a healthier lifestyle it is imperative to stay motivated however the number of barriers preventing healthy eating is increasing. Paradoxically, the prevalence of both eating disorders and obesity has been increasing in developed countries during the past few decades and ironically, dieting has been viewed as contributing factor to both problems [28]. Clearly the consumption of unhealthy meals as well as lack of meals can contribute to the obesity epidemic.

Eating behavior can be affected through both, physical and psychological barriers, which could have either a positive or a negative impact. Physical barriers include time, cost and unavailability whilst willpower and eating habits are considered psychological [29]. In addition, according to a study on determinants of eating behavior amongst students, the individuals eating habits were influenced by "individual factors (e.g. taste preferences, self-discipline, time and convenience), their social networks (e.g. (lack of) parental control, friends and peers), physical environment (e.g. availability and accessibility, appeal and prices of food products), and macro environment (e.g. media and advertising)" [9].

Motives to eating healthy can be categorized in terms of being intrinsic or extrinsic. An intrinsic motive includes 'self-image' and 'personal health' which leads to rewards that are internal to the individual as opposed to extrinsic motives which leads to external rewards or punishments such as approval or disapproval of others [29]. According to Deci [8], intrinsic motivation is also associated with a reward but focuses on the physiological pleasure or satisfaction such as leading a healthy lifestyle to

'look good' and have self-confidence for their own reasons. Alternatively, extrinsic motivations are defined as "engaging in an activity to obtain and outcome that is separable from the activity itself" [7, 24] where the reason for an activity would solely revolve around the rewards or punishment aspect. For example, extrinsic motives can include pressures to conform to society's perspective of being 'good looking' or having the medias perception of an ideal figure. Moreover, societal pressures have been indicated as one of the principal factors which lead to individuals initiating losing weight [44]. Indeed, it is argued that some degree of dissatisfaction may be helpful and necessary to motivate individuals to engage in health behaviors such as exercise [17].

Moreover, several studies have concluded that food has a momentous impact on the behavior and moods of individuals as well. Unhealthy and unbalanced diets that consist of high sugar content and starch filled carbohydrates lead to internal problems such as hypoglycaemia [27], which causes the brain to secret glutamate at levels that cause agitation, depression and anxiety. Moreover, healthier diets support cognition, problem solving and memory, which are noted benefits leading to brain development [27].

2.3 Persuasive Technology and Captology

Persuasive technology is defined as any interactive computing system designed to change or alter individual's attitudes or behaviors by applying psychological principles of persuasion including principles of credibility, trust, reciprocity and authority [11]. It has been used in many disciplines including advertising, marketing, games and healthcare. Particularly, it has been used in encouraging good eating habits [19] and Internet advertising [23]. The use of persuasive technology to motivate healthy behavior change is a growing area of research within human computer interaction (HCI) and ubiquitous computing, with the evolving field increasingly being targeted to influence behavior in the area of health and wellness [34]. With mobile phones dominating individual's lives in today's generation, it is imperative to utilize this platform to promote healthier lifestyles through mobile applications. Mobile phone applications, benefiting from their ubiquity, have been progressively used to address obesity. In order to increase the applications' acceptance and success, a design and development process that focuses on users, such as user-centred design, is necessary [16].

Fogg describes the development of applying persuasive techniques in computing technology as 'captology', whereby the design, research and analysis of interactive computing products are created to alter the attitudes and behaviors [11]. As a result, captology can be viewed as the overlap between computers and persuasion, which correlates around influencing behavior, and attitude change alongside computing technology. The combination of persuasion and technology lead to a well-structured background on persuasive technology.

Captology is defined as "the study of user's interactions with computers, focusing on the psychological drivers involved for pursuing an intended goal defined as change in people's behaviors or attitudes without coercion or deception" [11]. Although defined as a study of computers, it is in fact not limited to computer systems only but is open to other platforms such as websites, games, or for the context of this research, mobile applications. Development of applications using persuasion within healthcare to

motivate people towards healthy behavior have been identified as resulting in a possible delay, or even preventing medical problems [33].

Humans are arguably the strongest persuaders [18]. They tend to offer a presence and a valuable impact in persuading others to commit to long-term goals however, Fogg [11] suggests that technology can now have a number of distinct advantages over human persuaders. Some of which can allow anonymity, access and control to an unlimited store of data, of which these advantages are to be more persistent [18]. However, looking at distinct types of sync-able technology such as wearables and Android applications to match, it is clear that technology is now a necessity during physical activity.

3 The Persuasive Systems Design Model

To create efficacious persuasive technology, it is evident that unique design principles need to be taken into consideration with the design process for a higher possibility to modify user behaviors and attitudes. The Persuasive Systems Design Model, also known as the PSD model was introduced by Oinas-Kukkonen and Harjumaa [33] and is, to the best of our knowledge, currently the only comprehensive methodology for developing and evaluating persuasive systems. The PSD configures the design processes and provides a comprehensive list of system features and requirements that can be used during the development process. The PSD model has been used in the development of Behavioural Change Support Systems (BCSS) in order to define the overall process [2], to analyze the persuasion context [37, 48] and to design system qualities [10, 22]. Further related research associated with the use of the PSD model has been applied in the evaluation phases of existing systems by providing heuristics for expert evaluations [6] and systematic ways to analyze user experience data [4, 40].

The three phases are based on the principle that before any system is developed or implemented, it is central to understand the fundamental issues behind persuasive systems, which is the first stage of the model. Only once a reasonable level of understanding has been obtained, can the system be analyzed and designed. During the second stage of persuasion context analysis, the intent, event and strategies for using the persuasive application is a prerequisite to progress onto the final stage. The concluding stage consists of designing the system qualities for the proposed application or evaluating the features of an existing application [33].

Upon conducting conceptual analysis and empirical work, Oinas-Kukkonen and Harjumaa [33] have defined seven postulates which should be addressed when designing or evaluating persuasive systems. These entail how we see the users in general, persuasion strategies and addressing actual system features:

1. Information technology is never neutral.
2. People like their views about the world to be organized and consistent.
3. Direct and indirect routers are key persuasion strategies.
4. Persuasion is often Incremental.
5. Persuasion through persuasive systems should always be open.
6. Persuasive systems should aim at unobtrusiveness.
7. Persuasive systems should aim at being both useful and easy to use.

The second stage within the PSD requires an in-depth analysis and concrete understanding on the persuasion context. This constructs as an integral aspect which is vital in promoting the slightest behavior or attitude change. Analyzing the persuasion context requires a thorough understanding of what happens in the information-processing event, namely understanding the roles of persuader, persuadee, message, channel, and the larger context [32].

The final stage within the PSD model is System Qualities; here the designers must ensure the system incorporates a set of non-functional requirements [47]. There are 28 dissimilar principles organized into four categories that reflect the design of the system qualities including primary task support, dialogue support, system credibility and social support [33].

- **Primary Task Support**
  The design principles associated with primary task support essentially aid the user in carrying out the user's primary task. These include reduction, tunnelling, tailoring, personalisation, self-monitoring, simulation and rehearsal.
- **Dialogue Support**
  The dialogue support category relates directly to the actual interactive system that provides a degree of feedback to its users. An example of this may be a dialogue box providing ongoing moral support to the user as they reach closer to their goal. The design principles include praise, rewards, reminders, suggestions, similarity, liking and social role.
- **System Credibility**
  System credibility describes how to accurately design a system ensuring it is credible and persuasive. The design principles can include trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements, and verifiability. For example, if a user is searching for medical advice, they are likely to trust an established government organisation such as the NHS as opposed to a blog by a third year medical student.
- **Social Support**
  Social support defines how to design the system ensuring it motivates users by leveraging social influence. The design principles within this category include social facilitation, social comparison, normative influence, social learning, cooperation, competition, and recognition.

4 The PowerFIT App

Prior to beginning development work, a set of low-fidelity diagrams were generated to provide a foundation for developing the application. Developing a working application for evaluation is considered to be impractical [26], therefore a low-fidelity prototype was created on the basis of the gathered user requirements and persuasive design principles. User requirements were gathered through two iterations with a focus group comprising 10 participants and were complemented by best practice identified from the state-of-the-art literature on usability and persuasive systems design.

4.1 Splash and Welcome Screens

To begin with, the user will view a splash screen as shown in Fig. 1. The screen allows the user to begin using the application using the 'Start' button; alternatively, the application will automatically continue onto the main screen after a few seconds. Though the splash screen does not explicitly highlight that the application is free, this is evident whilst downloading the application from the play store. A free application should enable the user to reciprocate and repay the favor (the reciprocation principle). The color scheme and button format have been deliberately designed with curved edges for a soft look and feel to application with a light color scheme. Figures 1 and 2 show the Android application being run on a Google Nexus 7. Figure 2 shows the welcome screen with the options to Register, Login or view Help. The welcome screen also provides the user with the option to go 'Back' and exit the application.

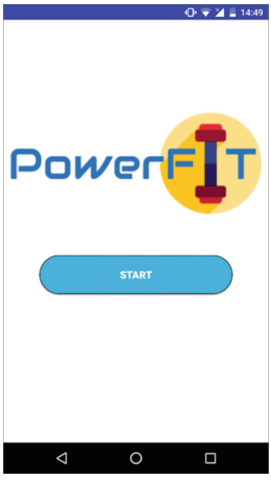

Fig. 1. PowerFIT splash screen

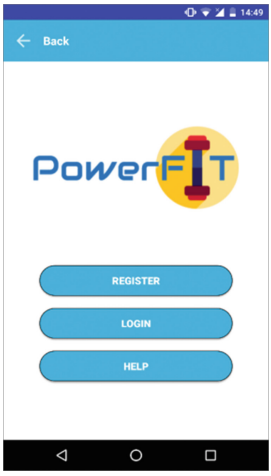

Fig. 2. PowerFIT welcome screen

4.2 Login and Home Screens

Once users have completed registration, they are directed to the 'Login' page to input their email and password as highlighted in Fig. 3. The password is encrypted as the users for security purposes. Upon logging in, the user is directed to the main page as shown in Fig. 4. From here, the user can opt to use any of the following features: Route Tracker, Track My Steps, Reminders or Food & Calorie Log.

4.3 Route Tracker

The 'Route Tracker' functionality allows the users to define a route for their journey using google maps within the application. The user can specify a 'From' and 'To'

Fig. 3. PowerFIT login screen

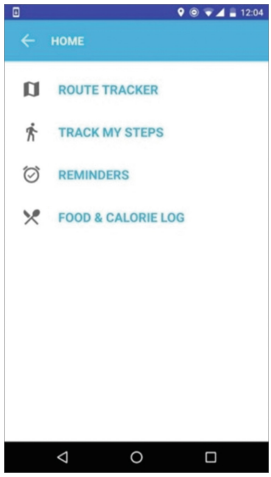

Fig. 4. PowerFIT home screen

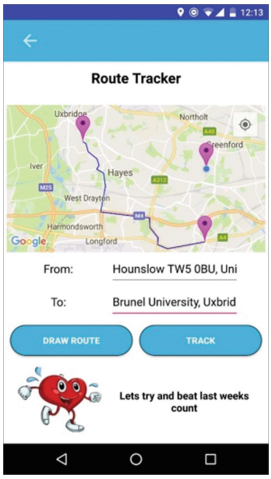

Fig. 5. PowerFIT route tracker

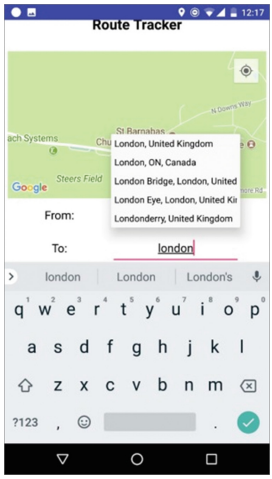

Fig. 6. Destination auto selection

destination and select 'Draw Route' which will highlight the route on the map and has the ability to search any location from the text box (Fig. 5).

The functionality includes the Google Maps API which is required to work alongside the 'Pedometer' feature. Given most mobile applications already have a map feature, the use of google maps will be a familiar function for the user and prevents them from having to learn the feature again. The map provides a visual view of the

route for the user making the feature self-explanatory and user friendly and thus allows the user to track their physical activity session for jogging or walking.

To ensure the application is easy to use and convenient, the starting and ending destinations can be selected from an auto-populated suggestion. Figure 6 illustrates the destination suggestions depending on the initial characters typed.

The use of a social actor in the form of a small character has been incorporated to guide users through various processes and provide motivation. The social actor will display a series of randomly generated motivational quotes, and praises to help the user attain the best performance. The intention is to utilize this character to tempt the individuals to pick a longer route and to encourage a healthy challenge to accomplish as well as provide motivation when the users may lack the urge to increase physical activity.

The Route Tracker and the Pedometer correlate to one another as the user can draw their desired route in the Route Tracker screen and select 'Track' which will direct the users onto the 'Pedometer screen'.

4.4 Calorie Log

Possessing the ability to count your calories throughout the day is an important task that should be completed when setting out physical exercise goals. Physical activity yields a significant amount of benefits alone, however to maximize the results an in-depth log of the individual's calories must be counted and logged. This will provide the individual an insight to whether they need to promote a calorie surplus or a calorie deficit. This feature will enable the individual to successfully search for the food they have consumed and be able to add this to their log that can then be totaled towards the end of the day of week. The calorie log successfully searches for food and adds the total onto the table on screen (Fig. 7).

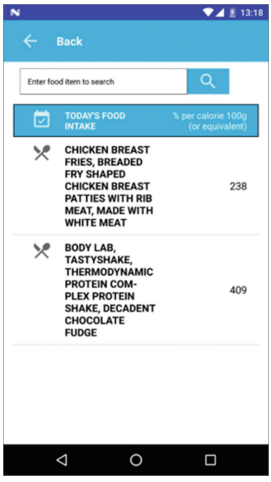

Fig. 7. PowerFIT calorie log

4.5 Evaluation

An individual think aloud session was held with the original participant group to evaluate and analyze the final solution. The purpose of expending the think aloud approach is to facilitate systematic data collection in a controlled environment and support the identification of usability problems that are experienced in the use of the application [21]. Participants were asked to explore the app without restrictions throughout the session and provide their honest thoughts on the design, features available and usability. The intention was to understand the user's attitude towards the application and to assess whether they are likely to use the application long term. The session will follow the very same process as the data gathering sessions but will be categorized against the requirements.

The data collated from the think aloud sessions have been grouped into common themes in relation to this project. Generally, the participants favored the application and provided positive feedback as well as constructive negative feedback. All users stated that they were inclined to use and explore the application and seemed enthusiastic to view their progress over a period of time. The feedback has been categorized into common themes as outlined below in Table 1 below:

Table 1. Think aloud evaluation summary.

Theme 1: Aesthetics
The application was well received amongst the participants, particularly the bright base and the logo. Due to the negative perception on the Fitness Pal logo which was perceived as targeted for males only, the logo for PowerFIT was exceptionally well received with users reacting positively to the color scheme and gender neutral design. All participants found the application formatting to be visually appealing and preferred the minimalistic design approach
Theme 2: Ease of Use
Applications should be effortless and make things easier for the user (Whalen 2011). Participants mentioned that the application was self-explanatory with the navigation and usability of the application being 'straightforward' and 'easy to understand'. They favored that all functions were visible and not hidden. A minority of participants stated that they would prefer and 'Help' page on each screen as opposed to going back to the Home screen
Theme 3: Color Scheme
Following on from the initial data gathering sessions it was evident that all participants preferred a neutral color scheme. This was then taken in to consideration and implemented into the application which was well received and considered to be one of the key favorite aspects as the application was 'fresh' and 'inviting'. The consistency has remained throughout the application in the form of color scheme and fonts however, some negative responses included that the use of pink and blue felt to be too diverse when selecting fields to type in, they preferred it stayed the same color. Additionally as the logo had shades of yellow present, users expected yellow in the application

(*continued*)

Table 1. (*continued*)

Theme 4: Features
All participants likened the motivational prompts as well as the ability to view their progress on the pedometer and the calories lost. Users stated that the ability to create the timing of the reminders was convenient as their routines changed; making it easier to suit the app to the users' needs though, they did find this to be a manual task. This represents 'status quo' as the concept is adaptable to fit the users' life (Whalen, 2011). To add, the option to configure the journey pace as 'Walk' or 'Run' was pleasing for all participants as they felt they had control over the pace of the exercise. The consistency of having an existing functionality such as Google maps on a phone that has been incorporated into the application received positive feedback, as all users knew how to use the feature. It is significant that the application is consistent as it provides the user with familiarities, which increases its likeability

5 Conclusions

The aim of the work reported in this paper was to investigate whether persuasive design principles can be integrated in the form a modern mobile application that encourages young adults to lead a healthier lifestyle and increase their motivation to exercise frequently.

A fundamental achievement highlighted following an evaluation of the developed mobile application is that persuasive design principles do have a positive impact on users and it has the potential to determine the success or failure of a mobile application. Although it is difficult to assess whether the application can change behavior long-term and whether or not it assists in tackling obesity, it is evident that users are encouraged to use the application and attempt the new behavior, which is likely to change their behavior for the time being.

References

1. Ahlgren, C., Hammarström, A., Sandberg, S., Lindahl, B., Olsson, T., Larsson, C., Fjellman-Wiklund, A.: Engagement in new dietary habits—obese women's experiences from participating in a 2-year diet intervention. Int. J. Behav. Med. **23**(1), 84–93 (2016)
2. Alahäivälä, T., Oinas-Kukkonen, H., Jokelainen, T.: Software architecture design for health BCSS: case onnikka. In: Berkovsky, S., Freyne, J. (eds.) PERSUASIVE 2013. LNCS, vol. 7822, pp. 3–14. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-37157-8_3
3. Anderson, R.J., Brice, S.: The mood-enhancing benefits of exercise: memory biases augment the effect. Psychol. Sport Exerc. **12**(2), 79–82 (2011)
4. Basic, J., Yadamsuren, B., Saparova, D., Ma, Y.: Persuasive features in a web-based system for weight-loss team competition. In: Stephanidis, C. (ed.) HCI 2013. CCIS, vol. 374, pp. 125–129. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-39476-8_26
5. Brancati, F.L., Kao, W.L., Folsom, A.R., Watson, R.L., Szklo, M.: Incident type 2 diabetes mellitus in African American and white adults: the Atherosclerosis Risk in Communities Study. JAMA **283**(17), 2253–2259 (2000)

6. Chang, T.-R., Kaasinen, E., Kaipainen, K.: Persuasive design in mobile applications for mental well-being: multidisciplinary expert review. In: Godara, B., Nikita, K.S. (eds.) MobiHealth 2012. LNICST, vol. 61, pp. 154–162. Springer, Heidelberg (2013). https://doi.org/10.1007/978-3-642-37893-5_18
7. DeCharms, R.: Personal Causation: The Internal Affective Determinants of Behavior. Academic Press, New York (1968)
8. Deci, E.L.: Effects of externally mediated rewards on intrinsic motivation. J. Pers. Soc. Psychol. **18**, 105–115 (1971)
9. Deliens, T., Clarys, P., De Bourdeaudhuij, I., Deforche, B.: Determinants of eating behaviour in university students: a qualitative study using focus group discussions. BMC Public Health **14**(1), 53 (2014)
10. Derrick, D.C., Jenkins, J.L., Nunamaker Jr., J.F.: Design principles for special purpose, embodied, conversational intelligence with environmental sensors (SPECIES) agents'. AIS Trans. Hum. Comput. Interact. **3**(2), 62–81 (2011)
11. Fogg, B.J.: Persuasive Technology. Morgan Kaufmann Publishers, Amsterdam (2003)
12. Gao, C., Kong, F., Tan, J.: Healthaware: tackling obesity with health aware smart phone systems. In: Proceedings IEEE International Conference on Robotics and Biomimetics (ROBIO), pp. 1549–1554. IEEE (2009)
13. Ghinea, G., Spyridonis, F., Serif, T., Frank, A.O.: 3-D pain drawings–mobile data collection using a PDA. IEEE Trans. Inf Technol. Biomed. **12**(1), 27–33 (2008)
14. Golden, N.H., Schneider, M., Wood, C.: Preventing obesity and eating disorders in adolescents. Pediatrics **138**(3), e20161649 (2016)
15. Hansen, J., Gronli, T.M., Ghinea, G.: Cloud to device push messaging on android: a case study. In: Proceedings 6th International Conference on Advanced Information Networking and Applications Workshops (WAINA), pp. 1298–1303. IEEE (2012)
16. Hermawati, S., Lawson, G.: Managing obesity through mobile phone applications: a state-of-the-art review from a user-centred design perspective. Pers. Ubiquit. Comput. **18**(8), 2003–2023 (2014)
17. Hu, F.B., Stampfer, M.J., Colditz, G.A., Ascherio, A., Rexrode, K.M., Willett, W.C., Manson, J.E.: Physical activity and risk of stroke in women. JAMA **283**(22), 2961–2967 (2000)
18. IJsselsteijn, W., de Kort, Y., Midden, C., Eggen, B., van den Hoven, E.: Persuasive technology for human well-being: setting the scene. In: IJsselsteijn, W.A., de Kort, Y.A.W., Midden, C., Eggen, B., van den Hoven, E. (eds.) PERSUASIVE 2006. LNCS, vol. 3962, pp. 1–5. Springer, Heidelberg (2006). https://doi.org/10.1007/11755494_1
19. Intille, S.S., Kukla, C., Farzanfar, R., Bakr, W.: Just-in-time technology to encourage incremental, dietary behavior change. In: Proceedings AMIA Annual Symposium Proceedings, p. 874 (2003)
20. Kivimäki, M., Kuosma, E., Ferrie, J.E., Luukkonen, R., Nyberg, S.T., Alfredsson, L., Knutsson, A.: Overweight, obesity, and risk of cardiometabolic multimorbidity: pooled analysis of individual-level data for 120 813 adults from 16 cohort studies from the USA and Europe. Lancet Public Health **2**(6), e277–e285 (2017)
21. Kjeldskov, J., Stage, J.: New techniques for usability evaluation of mobile systems. Int. J. Hum Comput Stud. **60**(5–6), 599–620 (2004)
22. Langrial, S., Oinas-Kukkonen, H., Wang, S.: Design of a web-based information system for sleep deprivation – a trial study. In: Eriksson-Backa, K., Luoma, A., Krook, E. (eds.) WIS 2012. CCIS, vol. 313, pp. 41–51. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-32850-3_4

23. Lee, J.K., Lee, J.W.: Internet advertising strategy by comparison challenge approach. In: Proceedings of the 5th International Conference on Electronic Commerce, pp. 450–457 (2003)
24. Lepper, M.R., Greene, D.: The Hidden Costs of Reward. Lawrence Erlbaum Associates, Inc., Hillsdale (1978)
25. Leswing, K.: Pokémon Go was most downloaded iOS app worldwide in 2016, Apple says. Business Insider (2017)
26. Lim, Y.K., Pangam, A., Periyasami, S., Aneja, S.: Comparative analysis of high-and low-fidelity prototypes for more valid usability evaluations of mobile devices. In: Proceedings of the 4th Nordic Conference on Human-Computer Interaction: Changing Roles, pp. 291–300. ACM (2006)
27. Linus Pauling Institute Cognitive Function in Depth. http://lpi.oregonstate.edu/mic/health-disease/cognitive-function. Last Accessed 20 June 2017
28. Lowe, M., Levine, A.: Eating motives and the controversy over dieting: eating less than needed versus less than wanted. Obes Res. **13**(5), 797–806 (2005). North American Association for the Study of Obesity
29. Michaelidou, N., Christodoulides, G., Torova, K.: Determinants of healthy eating: a cross-national study on motives and barriers. Int. J. Cons. Stud. **36**(1), 17–22 (2012)
30. Neumark-Sztainer, D.: Preventing obesity and eating disorders in adolescents: what can health care providers do? J. Adolesc. Health **44**(3), 206–213 (2009)
31. Nikolaou, C.K., Lean, M.E.J.: Mobile applications for obesity and weight management: current market characteristics. Int. J. Obes. **41**(1), 200 (2017)
32. Oinas-Kukkonen, H., Harjumaa, M.: A systematic framework for designing and evaluating persuasive systems. In: Oinas-Kukkonen, H., Hasle, P., Harjumaa, M., Segerståhl, K., Øhrstrøm, P. (eds.) PERSUASIVE 2008. LNCS, vol. 5033, pp. 164–176. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-68504-3_15
33. Oinas-Kukkonen, H., Harjumaa, M.: Persuasive systems design: key issues, process model, and system features. Commun. Assoc. Inf. Syst. **24**(1), 28 (2009)
34. Orji, R., Moffatt, K.: Persuasive technology for health and wellness: state-of-the-art and emerging trends. Health Inf. J. **24**, 66–91 (2016)
35. Poole, L., Steptoe, A., Wawrzyniak, A.J., Bostock, S., Mitchell, E.S., Hamer, M.: Associations of objectively measured physical activity with daily mood ratings and psychophysiological stress responses in women. Psychophysiology **48**(8), 1165–1172 (2011)
36. Public Health England. https://www.gov.uk/government/publications/health-matters-obesity-and-the-food-environment/health-matters-obesity-and-the-food-environment–2. Last Accessed 07 Feb 2018
37. Purpura, S., Schwanda, V., Williams, K., Stibler, W. Sengers, P.: Fit4life: the design of a persuasive technology promoting healthy behavior and ideal weight. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 423–432. ACM, New York (2011)
38. Reed, J., Ones, D.S.: The effect of acute aerobic exercise on positive activated affect: a meta-analysis. Psychol. Sport Exerc. **7**(5), 477–514 (2006)
39. Salici, A.G., Sisman, P., Gul, O.O., Karayel, T., Cander, S., Ersoy, C.: The prevalence of obesity and related factors: an urban survey study. Endocr. Abstr. **49**(EP679) (2017). https://doi.org/10.1530/endoabs.49.ep679
40. Segerståhl, K., Kotro, T., Väänänen-Vainio-Mattila, K.: Pitfalls in persuasion: how do users experience persuasive techniques in a web service? In: Ploug, T., Hasle, P., Oinas-Kukkonen, H. (eds.) PERSUASIVE 2010. LNCS, vol. 6137, pp. 211–222. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-13226-1_22

41. Serif, T., Ghinea, G.: Recording of time-varying back-pain data: a wireless solution. IEEE Trans. Inf Technol. Biomed. **9**(3), 447–458 (2005)
42. Spyridonis, F., Hansen, J., Grønli, T.M., Ghinea, G.: PainDroid: an android-based virtual reality application for pain assessment. Multimed. Tools Appl. **72**(1), 191–206 (2014)
43. Statista. Annual number of mobile app downloads worldwide 2021|Statistic. https://www.statista.com/statistics/271644/worldwide-free-and-paid-mobile-app-store-downloads/. Last Accessed 03 June 2017
44. Stevenson, C., Doherty, G., Barnett, J., Muldoon, O., Trew, K.: Adolescents' views of food and eating: identifying barriers to healthy eating. J. Adolesc. **30**(3), 417–434 (2007)
45. Sturm, R.: The effects of obesity, smoking, and drinking on medical problems and costs. Health Aff. **21**(2), 245–253 (2002)
46. Verloop, J., Rookus, R.A., van der Kooy, K., van Leeuwen, F.E.: Physical activity and breast cancer risk in women aged 20-54 years. J. Nat. Cancer Inst. **92**(2), 128–135 (2000)
47. Wiafe, I., Alhammad, M.M., Nakata, K., Gulliver, S.R.: Analyzing the persuasion context of the persuasive systems design model with the 3D-RAB model. In: Bang, M., Ragnemalm, E. L. (eds.) PERSUASIVE 2012. LNCS, vol. 7284, pp. 193–202. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-31037-9_17
48. Young, M.M.: Twitter me: using micro-blogging to motivate teenagers to exercise. In: Winter, R., Zhao, J.L., Aier, S. (eds.) DESRIST 2010. LNCS, vol. 6105, pp. 439–448. Springer, Heidelberg (2010). https://doi.org/10.1007/978-3-642-13335-0_30
49. Zheng, Y., Manson, J.E., Yuan, C., Liang, M.H., Grodstein, F., Stampfer, M.J., Willett, W. C., Hu, F.B.: Associations of weight gain from early to middle adulthood with major health outcomes later in life. JAMA **318**(3), 255–269 (2017)